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ABSTRACT (Maximum 200 words)  DERA is comprised of the former non-nuclear research, test & evaluation and scientific/technical services of the UK Ministry of Defence (MOD). It is the largest research organization of its kind in Europe, is comprised of some 12,000 staff, of whom over 6,000 are scientists, is based on several sites around the United Kingdom and has offices in several international cities, including Brussels and Moscow. DERA is composed of hundreds of specialist teams, each of which is an expert in its particular technology or facility. These teams encompass research, analytical studies, test and evaluation of operational equipment, and research into human effectiveness and protection. Although it has been an Agency of the MOD since April 1991, the former constituent parts brought their knowledge and expertise with them, so that DERA's expertise can be traced back over many years. In addition to its military customers, DERA also works closely with government and industrial laboratories in the United States and Europe and sponsors Russian participation through the Programme for Partnership in Technology. DERA's links with industry are an essential aspect of its role as a research agency for the MOD, where an ultimate aim is the production of equipment based on joint research and development. Active support is given to the transfer of technology in both directions between DERA, industry and academia through: <ul style="list-style-type: none"> <li>• collaboration and sub-contract research</li> <li>• evaluating and influencing the development of Commercial Off The Shelf products</li> <li>• Creation and support of Science Parks on several DERA sites</li> <li>• Creation and support of 5 Dual Use Technology Centres: <ul style="list-style-type: none"> <li>- The Centre for Marine Technology</li> <li>- Mechanical Sciences Centre</li> <li>- Farnborough Supercomputing Centre</li> <li>- Systems and Software Engineering Centre</li> <li>- Information Processing &amp; Telecommunications Centre</li> </ul> </li> </ul> This document gives a brief description of DERA's technologies and capabilities at Malvern, covering the fields of Communications, Electronics and IT (Information Technologies).				
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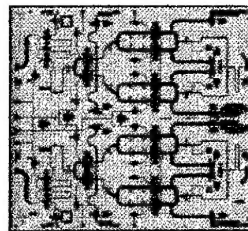
# DERA

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## TECHNOLOGIES AND CAPABILITIES IN:



### COMMUNICATIONS



### ELECTRONICS



### IT (Information Technologies)

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## INTRODUCTION

DERA is comprised of the former non-nuclear research, test & evaluation and scientific/technical services of the UK Ministry of Defence (MOD). It is the largest research organisation of its kind in Europe, is comprised of some 12,000 staff, of whom over 6,000 are scientists, is based on several sites around the United Kingdom and has offices in several international cities, including Brussels and Moscow.

DERA is composed of hundreds of specialist teams, each of which is an expert in its particular technology or facility. These teams encompass research, analytical studies, test and evaluation of operational equipment, and research into human effectiveness and protection.

Although it has been an Agency of the MOD since April 1991, the former constituent parts brought their knowledge and expertise with them, so that DERA's expertise can be traced back over many years.

In addition to its military customers, DERA also works closely with government and industrial laboratories in the United States and Europe and sponsors Russian participation through the Programme for Partnership in Technology.

DERA's links with industry are an essential aspect of its role as a research agency for the MOD, where an ultimate aim is the production of equipment based on joint research and development. Active support is given to the transfer of technology in both directions between DERA, industry and academia through:

- collaboration and sub-contract research
- evaluating and influencing the development of Commercial Off The Shelf products
- Creation and support of Science Parks on several DERA sites
- Creation and support of 5 Dual Use Technology Centres:
  - The Centre for Marine Technology
  - Mechanical Sciences Centre
  - Farnborough Supercomputing Centre
  - Systems and Software Engineering Centre
  - Information Processing & Telecommunications Centre

This document gives a brief description of DERA's technologies and capabilities at Malvern, covering the fields of Communications, Electronics and IT (Information Technologies).

**Central Enquiries Desk: 01252 393300**

## DERAtec

Market Plans & Strategy  
Marketing Communications  
Technology Transfer  
Science Parks  
Support to the Bid Process  
Intellectual Property  
Central Contracts Support



DERAtec provides the interface between DERA's Business Sectors and potential customers. It was set-up in April 1998 to work as a partner, not competitor, with industry and to develop a wider civil customer base. It is divided into four business areas:

**Business Development:** - the central marketing function, which provides a central focus of sales and marketing to support the sales activities of the Business Sectors.

**Market Areas:** Nine main areas have been established, each with a Market Area Manager to plan and guide their business:

- Aerospace
- Environment
- Security
- Transportation
- ITEC (Information Technologies, Electronics & Communications)
- Defence
- Finance
- Healthcare
- Marine

**Market Area Managers:** have various tools at their disposal, including heading-up their Market Focus Group which networks people interested in their market area. They are able to use the wide range of marketing tools, including general networking, attendance at exhibitions, participation in market orientated events, and membership of appropriate industry forums.

**Marketing Communications and Information Group:** plans communications and thereby connects Market Area Managers with their customers, as well as providing advice and production capabilities for promotional activities.

**Corporate Web Site:** currently typically receives 150,000 hits a week and is considering adapting the Internet site to make it a more interactive source for customers.

**Business Information Service:** provides a wide range of business information and market research.

**Central Enquiries Desk:** is the first contact point for many of DERA's existing and future customers, including industrial partners and DERA staff.

**New Ventures:** - aims to develop novel, long-term business and technology transfer channels, including: Science Parks; Joint ventures; Partnerships; Strategic alliances; New markets; and Developing relationships with business organisations.

Defence Diversification Agency: The extension of DERA's technology transfer activities providing a two-way information channel between civil and defence industries.

Science Parks: are being organised at DERA sites including Farnborough, Haslar, Malvern and Porton. Entrepreneurs from both DERA and outside will be encouraged to take advantage of these facilities to transform their ideas into products. Simplified processes will give easy access to DERA technology, making it easier for small business to do business with DERA.

Joint Ventures: Arrangements to couple into the Business Links network of Innovation & Technology Councillors are being established. Work is also proceeding to investigate a wide range of Joint Ventures with industry.

Project Consultancy Group: provides a ready and cost-effective source of business support to prepare bids, offers commercial advice and represents DERA in developing new business. It also provides an experienced project management capability which can be called upon to fill temporary gaps in Business Sector resources.

Inventiveness in Science: routes to wealth creation are encouraged. These have included 'Inventiveness in Science' teams and 'Creativity & Innovation Investment' schemes.

**Intellectual Property:** One of DERA's greatest assets is its intellectual property (IP) in the form of patents, trademarks, designs and software which covers work undertaken for MOD and commercial customers alike. DERA's IP is: licensed, used to promote research capabilities through collaboration, to aid technology transfer and to promote joint ventures.

The Intellectual Property Department: covers clearing of publications, preparing confidentiality agreements, prosecuting patents, providing top-level advice on IP policy and negotiating licensing deals.

The team includes European patent attorneys able to cover all areas of DERA's technical expertise and a legal advisor capable of dealing with the issues surrounding DERA's increasingly complex business.

**Contracts:** Each Business Sector has its local contracts staff to advise and negotiate on its behalf. The Central Contracts Group provides support and professional guidance to the sales process and handles head office contracts.

In particular, the group handles contracts policy and continuous improvements in the form of new systems, processes and staff training. It deals with routine MOD work and the increasingly diverse range of commercial contracting. It ensures that contracting policy keeps abreast of the rapidly changing business and is helping to streamline the process.

## **INFORMATION PROCESSING & TELECOMMUNICATIONS**

### **(IPT) INNOVATION CENTRE**

Reduction of Financial Risks  
Access to Emerging Technologies  
Conferences & Seminars  
Staff Secondment & Co-ordination  
Access to DERA Expertise  
Over 6,000 Patents for Exploitation  
Technology Clubs



Based at DERA Malvern, the IPT Innovation Centre was opened in June 1997 to promote the transfer of technology between the defence and civil sectors. In April 1998 DERAtec was formed, which is responsible centrally for market intelligence and new venture/technology transfer.

The IPT Innovation Centre is therefore now able to focus on facilitating technology transfer in its field of expertise, by taking opportunities and projects identified by DERAtec and the DERA Business Development Managers and implementing or nurturing them until they are established.

Using its diverse knowledge and skills, the Centre provides the versatile hands-on management necessary to resolve day to day problems peculiar to new ventures, to advise on sources of new funding, arrange seminars and training courses, and to identify further opportunities both through its contacts and by working with the Intellectual Property database.

The wide range of services provided by the Centre includes:

#### **Technology Transfer Support**

Management of technology transfer process  
Licensing and IPR expertise  
Sign posting to sources of finance  
Project management

#### **Specialist Technical Information**

Training courses  
Seminars  
Workshops  
Technology clubs

#### **Collaborative Opportunities**

Technical consultancy  
Contract research  
Prototype development

#### **Central Point of Access**

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DERA  
St. Andrews Road, Malvern, WR14 3PS  
Tel: +44 (0)1684 896017  
Fax: +44 (0)1684 896554  
E-Mail: JPLloyd@dera.gov.uk

### **Areas of DERA Expertise Covered**

#### **Information Technology**

Information & system security  
Information and knowledge management  
Multimedia and electronic networking  
Electronic patient records

#### **Information Processing**

Speech recognition  
Signal and image processing  
Data mining  
High speed processing  
Neural networks  
Medical imaging

#### **Enabling Devices**

High performance semiconductors  
Microwave devices  
Photonics devices and systems  
Image capture  
2D and 3D displays  
Optical interconnects  
Advanced medical sensors

#### **Software Systems**

Systems engineering  
Software quality  
Software process improvement  
Open systems interoperability  
High integrity systems  
Simulation and synthetic environments  
Medical training simulators

#### **Telecommunications**

Information exchange requirements  
Radio planning tools  
Asynchronous Transfer Mode research  
Communications security  
Network modelling and simulation  
Telemedicine, including:-  
    Remote patient monitoring  
    Teleconsulting

### **Activities undertaken by the Centre since inception in 1997**

- Launch seminars (in association with DTI)
- Technology Showcase Open Day
- Workshop - Year 2000 Problem
- Course - Image Processing and Understanding
- Creation of DERA Java Centre (in association with Sun Microsystems Ltd)
- Building Telemedicine Capability (to serve MOD and NHS)
- Bidding into selected EU projects
- Bids to support various SMEs/Entrepreneurs
- Project Management for regional initiative "Networking Business & The Community"
- Hosting a meeting of The Cogsys Club Ltd (TCCL)

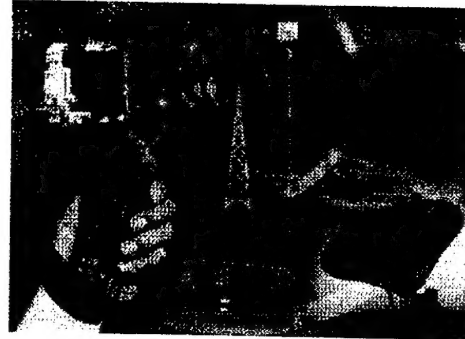
### **Future Plans**

- Continued building of DERA Java Service, enlarging into local Industry
- Continued building of Telemedicine capability
- 2nd Technology Showcase (as Themed Open Days)
- Malvern Hills Science Park (Technology Transfer Base)
- Identification & development of IPR database potential
- Initiating & nurturing new projects as identified
- Further Seminars & Training Courses



## COMMUNICATIONS DEPARTMENT

RF and mobile digital communications  
RF propagation modelling  
Antenna and RF systems  
Satellite communications  
Satellite communications ground segment  
Land/Air user Satcoms terminals  
Maritime communications  
Fixed ground communications  
Network simulation



The Communications Department conducts research and provides support and advice for procurement in all areas of communications behaviour; from Very Low Frequency (VLF) to Optical Frequencies in all environments from underwater to space, including communications from, to, and between mobile platforms.

The Department is no longer asked by the MOD to design specific products, eg: a radio, but might be asked to design and build an item to resolve a specific need, eg: an interface to interwork with an existing network.

90% of the Department's work is for, or in support of, MOD business. Links with industry are largely defined by the work undertaken for the MOD. Strong links exist with many companies which are available for exploitation for non-MOD work. Such companies range from the largest defence contractors to local SMEs.

Up to 30% of the Department's work is sub-contracted to industry, including collaboration on products such as *Crumpet* (Science Systems [Industrial] Ltd) and *Jive* (BAe SEMA Ltd).

The Department builds links with industry and develops spin-off potential through working with industry in pursuit of its MOD business, collaboration activities in pursuit of its research, and attendance at exhibitions and seminars - both exhibiting and visiting.

In the case of contacts through exhibitions, companies are identified with whom there seems to be areas of common interest and these are developed through mutual visits and exchanges of information.

## **Technologies:**

**CRUMPET:** Computer based design tool for planning communication area coverage in today's crowded electromagnetic spectrum. Computerised methods have been available for years but most take hours, Crumpet takes seconds. Features include instant point-to-point pathloss prediction; full UK terrain database at 100 or 50 metre resolution; multiple transmitters allowing for interference or reinforcement calculation; easy visualisation and interpretation; powerful graphical interface; road map backdrops and 3-D contour plots. Runs on a PC. Jointly developed with University of York, now licensed to Scientific Systems Ltd.

**JIVE:** Tactical HF communications decision aid providing HF signal coverage predictions; uses ITU prediction models; sky and ground waves are calculated simultaneously; predicts 24 hour frequency schedules for minimum signal interception; applicable to HF scenario modelling, COMPLAN, and tactical HF operating. Runs on a PC. Now licensed to BAe SEMA Ltd.

**DAMSON:** An oblique, pulse compression, HF sounder developed to characterise high latitude HF channels to achieve optimum performance. The irregular and dynamically varying nature of the ionosphere can severely hamper beyond line of sight HF communications. Performance can be optimised by characterising communication links for multipath and Doppler shifts and spreads. Damson, which was developed in collaboration with 4 other international partners, achieves this aim and has been supplied to, and is being used by, UK industry.

**Radio Propagation Survey & Consultancy Service:** Severe propagation problems can be experienced due to multipath fading, shadowing and delay spread. This service provides technical support into the causes, effects and mitigation of propagation phenomena by assessing, measuring and modelling the radio environment, before recommending mitigation techniques. Expertise includes digital mobile radio.

**Satellite Communications:** Numerous services have been developed to meet specific or general needs, including communications system management; management of resources, access and networks; access monitoring and policing subsystem; steerable antenna display system. Facilities to meet requirements of civil broadcasters are currently being acquired.

**Stress Model and Associated Tools:** Several software tools provide facilities for: Building models of communication networks and simulating them under stress; defining array antennae and access plans including simulating location of jammers and pattern optimisation; providing a graphical display (GUI) of the UK military Satcom system for entering communication requirements including choosing a transponder and ground segment route; automating the frequency planing process using a high level planning tool and producing a frequency for each allocation taking into account a multitude of parameters including equipment capability, international agreements, and intermodulation products.

**SATQUAT:** A set of algorithms to provide a backward pass, satellite link budget calculation for linear and limiting transponders, providing values of terminal and satellite output powers required to complete a satellite communications link. The algorithms also provide aggregate power values for each terminal and satellite transponder, and confirms suitable link margins.

**Direct Broadcast:** DERA is responsible for the design of the UK Direct Broadcast service covering all of the Satcom distribution options, and the information management and security aspects. The aim is to deliver high data rate broadcast to units deployed world-wide. DERA is also leading the UK investigations for military use of emerging civil Satcom systems covering handheld low voice; fax; and data services; through to high rate data point-to-point and broadcast services.

**Transmitter Location System:** Equipment to locate transmitters causing interference to satellite communications systems. A commercial service is offered to locate interferers - DERA holds a contract with Eutelsat for this service on a 24 hour basis. DERA are working with Logica to produce a marketable version.

**SATCOM Test Facility:** A facility to perform system and subsystem acceptance tests of satellite terminals by providing a representative satellite circuit for trials and acceptance testing of Modems and associated base equipment. Typical measurements include receiver/dish Gain-to-noise temperature ratio; transmitted equivalent isotropic radiated power; frequency accuracy; transmit stability; transmitter phase noise and link bit error rate.

**In Orbit Testing:** A powerful proprietary automatic test system is available for testing communication satellites based on ground terminals at DERA, Defford. The system has a wide range of options whilst the data analysis section takes into account ground station parameters; satellite attitude; payload configuration; antenna characteristics/position and propagation conditions. Two test can be run simultaneously for faster execution of test programmes.

**Automatic Bit Error-rate Testing:** Determination of the performance of RF Modems in terms of bit error rate against Signal to noise Ratio and input aggregate S+N for gaussian noise alone and/or together with various interference conditions. This test system has been used by industry to verify the performance of Commercial Off The Shelf (COTS) equipment.

**VLF Communications:** Extensive capability of modelling Very Low Frequency propagation, submarine antennae and receivers from message origination to reception; advanced test facility for performance evaluations of receiver systems; extensive experience in secure shore and submarine systems; communications centre integration covering conception to implementation.

**NETMAN:** A communications management and modelling resource offering a research platform, integrated toolset including assessment, planning and connectivity tools, and an expert consultancy service. Different communications architectures and structures can be readily defined and simulated eg: trunk or mobile radio networks. Netman has supported the Home Office and Broadcast companies in the UK and NATO HQ in Europe.

**BRAT:** Enables secure Cougar radios to be connected together via the Public Switched telephone Network. Allows connection of Cougar nets by BT phone or private wire line; extension of a Cougar net; access to a remote hilltop site via Outstation Link Control Unit for site control and interrogation; and local rebroadcast options. Ready for development by UK companies.

**X.21 Secure Interface Card:** Interfaces a standard PC to the BRENT secure telephone, thereby providing a secure data link over the public telephone network, plus non-secure voice to a standard analogue BT, or any mobile phone. The system is independent of the PC Operating system or application, requires minimum hardware set-up, and will co-reside with other X.21 cards to provide secure links to multiple destinations. Currently working at 64kb/s, a 128kb/s link is under investigation. Currently being evaluated by UK industry for commercial exploitation.

**TANDEM:** Asynchronous Transfer Mode demonstrator developed to investigate the use of ATM in hostile land environment over radio and SATCOM links. Provides ATM switches interconnected by fibre optic, radio and satellite links; flexible test bed; tactical link adaptation whilst maintaining genuine COTS ATM core; interoperability testing; performance assessment; concept proving; model validation and high capacity digital radio support.

**Advanced HF Network Model:** Significant advances in simulation technology allow realistic reproduction of communications within network architectures. This model provides for evaluation

of proposed system design options and configurations including Automatic Radio Control Systems (ARCS). The simulation tool provides benefits of repeatability for comparisons between techniques; flexibility for testing and simulation of typical and extreme scenarios.

**CSNI:** The Communication System Network Interoperability multi-national demonstrator is currently being exploited by UK industry to provide cost effective interoperability of different networks - Long Haul sub-networks, SHF Satcom; HF - through gateways to technologies including X.25, ISDN and GSM.

**On-Board Processing:** A demonstrator for a complete EHF satellite communications system using on-board processing to improve jam-resistance. Shown in trials to be inter-operable with the US Milstar system, a contract is in place enabling technology transfer to MMS for possible use in the next generation Skynet 5 military Satcom system.

**Satellite Access Management System:** A demonstrator for the fully automated network management (set-up, monitoring and tear-down) of satellite accesses operating within the UKMSCS. Groups of accesses sharing common requirements are organised into networks. User accesses within each network use a broadcast Network Control Unit and slotted, polled, time division multiple access, Report Back Network Control Unit. Joint development with MMS.

**Communications Modelling Support Facility:** Modern communication systems are extremely complex and must be evaluated under operational and overload conditions. This facility provides computer modelling to achieve detailed simulation with modelling of network management; performance; radio propagation; communications systems; and validation.

**HF Radio Systems for Civil Aviation:** This programme uses advanced computer technology, automatic channel selection and digital processing to achieve better than 95% circuit availability. It provides Modem design and coding; ionospheric studies and measurements; aircraft HF antenna modelling; polar diagram and efficiency measurements.

**Unified Communications System Advanced Research Technology:** A shop window of emerging technology for future military land communications in support of the Future Battlefield UCS. The demonstrator is used to shape existing and planned technology for the military market; identify military communications business opportunities; enhance the security of commercial systems and to expose new technology to the military environment.

#### **Capabilities:**

**RF Technology:** Modulation; coding and protocols; propagation and radio science; HF Station; VLF Testbed.

**Comms systems:** Requirements and performance assessment; architecture and management; systems security; vulnerability and exploitation; modelling and simulation; networks; maritime systems.

**SATCOM:** Ground, space and control segments including terminals; subsystems; test and operational facilities; management tools; signal processing and technology.

## **SPACE DEPARTMENT**

### **Space Systems**

- Procurement Support
- Mission Analysis
- Whole System Studies

### **Space technology**

- Environmental protection
- Microsatellite Development
- Ion thrusters

### **Remote sensing**

- Instrument Design
- Ground segment Facilities
- GIS Development



The space Department actively encourages collaboration with industry and academic institutions, both within the UK and overseas, across the whole spectrum of space technologies and applications.

Partnerships are actively fostered to develop fast and effective data provision from ground stations to commercial markets, and for space technology development.

The Space Department satellite ground station at West Freugh in Scotland provides the UK with a unique facility for receiving, processing and disseminating data from present and future generations of Earth Observation (EO) satellites. The department enters into collaborative arrangements to enable industry to participate directly in this growing market.

In addition industry partnership is the means for EO application technology transfer through developing prototype image analysis systems and demonstrators. For example, a radar interferometry system to monitor ground subsidence, originally developed by the department for a government programme, now forms the basis of a commercial service co-developed under license by a commercial partner.

The extensive facilities of Space Department are also available to organisations wishing to exploit or develop space technology and to participate in microsatellite missions. DERA's Space Technology Research Vehicle satellites are designed and built to test new technologies in the space environment, enabling industry and academia to gain competitive product advantage.

DERA's world-leading capability in ion thruster technology has benefited UK industry through collaborative development of the UK10 Ion Engine which will be used for north-south station keeping on the European Space Agency's Artemis spacecraft scheduled for launch in 1999. Further Ion Thruster products are being developed.

Overseas links are maintained through information exchange programmes and agreements with other countries pursuing space research and development. DERA also support the industry through involvement with a number of policy making committees such as the Inter-Agency Debris Committee, the United Nations Committee for the Peaceful Use of Outer Space and various ESA standards committees.

### **SERVICES FOR SPACECRAFT OWNERS AND OPERATORS**

**Support for Spacecraft Procurement:** Provision of expert consultancy and support to prospective spacecraft owners and operators. Services include studies for mission requirements, whole system studies, reliability analysis, environmental effects and launch support activities. The department currently provides contract support for the SKYNET and NATO series of military communications satellites, providing technical advice for missions, flight dynamics, anomaly investigations and telemetry processing.

**In-orbit Support for Spacecraft Operations:** Space Department provides satellite owners and operators with the back-up that is necessary for optimum management of operational spacecraft. This includes support for mission requirements studies, spacecraft reliability and environmental effects consultancy. Services also extend to launch support activities, in-orbit testing and operational 'troubleshooting'. Technical advice includes the conceptual design for satellite operations such as aspects of tracking, telemetry and command standardisation, and developing spacecraft monitoring systems and fault diagnostic tools.

**Ground Segment Development:** Research to improve ground segment capability and cost effectiveness, often through increasing spacecraft autonomy. For example the current DERA Space Technology Research Vehicle (STRV) programme is investigating the use of GPS for spacecraft positioning in low-Earth and Geostationary orbits to reduce operational costs through decreasing reliance on ground TT&C. Work includes the design and implementation of advanced facilities to provide a national ground segment for the British National Space Centre to make use of data from the ERS satellites.

## **SERVICES AND PRODUCTS FOR SPACECRAFT DESIGNERS AND BUILDERS**

**In-orbit Technology Demonstration Facilities:** A microsatellite development programme offers a complete space-based advanced technology demonstration service for commercial and military organisations. Using STRV spacecraft designed and built by Space Department, experimental data are returned quickly to allow the design of new spacecraft to be rapidly influenced. STRV 1a & 1b (launched 1994) carried 14 advanced technology experiments, and still functioned 4 years later. A follow-on mission STRV 1c & 1d carrying a further 25 experiments will be launched in 1999, after a 24 month construction and test programme.

**Spacecraft Environment and Protection Consultancy:** Assessment of threats to spacecraft from radiation, electrostatic charging and space debris by defining the interaction of the space environment with materials, electronics and sensors. The department offers consultancy covering operational risk analysis and shielding optimisation for spacecraft designers and operators.

**Spacecraft Propulsion:** Ion propulsion offers savings on spacecraft mass, improved reliability and enhanced performance. Space Department has developed with industry the T5 Ion Thruster due to be flown on the ESA Artemis satellite. Further improvements have recently resulted in the improved T6 design which allows complete orbit raising to geostationary altitudes.

**Power:** Accurate measurement of solar cell parameters to research enhancement of cost-effectiveness, efficiency and lifetime, whilst reducing mass and costs. Work involves the evaluation of new solar cell products through cell measurement, solar array testing and standards calibration.

**Space Test Facilities:** A comprehensive range of ground-based space simulation testing facilities is available to industry, research organisations and academic institutions for research, development and qualification testing of space hardware, instruments, components and satellites. These include a variety of thermal cycling vacuum chambers meeting a full range of environmental requirements, a large solar simulator, vibration test equipment and mass properties measurement equipment.

## **EARTH OBSERVATION PRODUCTS AND SERVICES**

**Ground Station Services and EO Data Products:** Ground stations are operated for EO data reception and rapid data dissemination at L, S and X bands, satellite tracking telemetry and command (TT&C). Data products are available from ERS, RADARSAT, GOES, Meteosat and NOAA series of satellites. Space Department is the primary source of meteorological satellite data for the United Kingdom, with some 200 images re-transmitted to the Meteorological Office daily. The department also operates a ground terminal for the international COSPAS/SARSAT search and rescue system, and is equipped as a command and control centre for small satellite operations.

**Earth Observation Application Research:** Space Department offers technical consultancy aimed at developing operational applications of Earth Observation data. Current areas of activity include terrestrial studies investigating sensitive change detection and topographic modelling and mapping techniques; oceanographic survey and Monitoring developing systems for detection, classification and monitoring of ships sea ice and surface ocean phenomena, and coastal map updating and change detection.

**Geographic Information Systems:** Development of software environments for integrating satellite remote sensing data into complex geographic analysis. Services include database design, tailored packaging for user-friendly applications, remote sensing, image processing and interpretation and environmental simulation. Examples of work include GIS landscape assessment for local authority, tourist board and estate agency applications, GIS applications for planning cross-country movement in areas of water obstacles, studies into GIS for land remediation in eastern Germany and collaborative development of a prototype "digital image map" product with industry.

**EO Instruments:** Services extend from basic design concepts and feasibility studies to the production of technology demonstrators and project management. Particular areas of expertise are microwave systems SAR and spacecraft antennae. DERA activities also support industry in the construction of operational systems through developing concepts into feasible technologies which can be commercially exploited. Work is also focused on specialised infra-red concepts which include space-based infra-red telescope technology demonstration. Utilising an advanced change detection technique, the instrument will identify aircraft signatures against the Earth's background.



## **Capabilities**

**Space Technology:** Research, development and consultancy covering all aspects of space technology, including spacecraft subsystems, attitude and orbit control systems, power systems, on-board data handling, materials and structures, thermal modelling and space debris. In addition Space Department is an acknowledged leader in the field of space environmental effects and ion propulsion.

**Space System Studies:** Analysis of future satellite and ground system requirements, procurement support, post launch mission analysis and resolution of spacecraft operating anomalies. Experience in the UK Skynet military communications programme is used to support overseas customers in the initial studies and procurement of new civil and military satellite systems.

**Earth Observation:** Capabilities include SAR and visible/IR instrument design, and research into the exploitation of satellite remote sensing data for both civil and military use. The activities are supported by two ground stations for operational reception of meteorological data and high resolution Radar data and near real-time delivery of application-specific products. DERA teams with industry to promote and develop commercially self-sustaining satellite remote sensing markets.

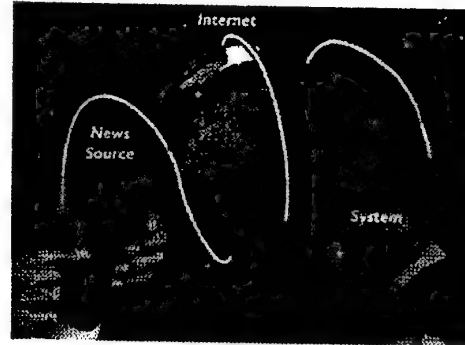
**Space Test Facilities:** A comprehensive range of test facilities is maintained, available to industry and academia, for qualification testing of space hardware, instruments, components and satellites.

**Microsatellites:** A microsatellite development programme is run, offering a complete service to organisations wishing to take advantage of the comprehensive DERA space capability. This includes complete systems, satellite design and predictive modelling, comprehensive testing, manufacture and the complete provision of ground segment facilities.



## INFORMATION SYSTEMS DEPARTMENT

Information Security  
Information Warfare  
Information Management  
Data Networks & Distributed Systems  
High Integrity Systems



Information Systems (IS) are fundamental to the effectiveness of current and future business, both in the civil and military environments. IS technology is expected to be a major growth area as we enter the 21st century.

The Information Systems Department aims to support its customers by undertaking contract research, and by providing support and advice on the main aspects of IS technology, and its application to specific IS projects.

To support this aim the Department offers a portfolio of services and capabilities including:

- Information Management
- Distributed Information Systems
- Information Security
- Information Warfare
- High Integrity Systems Assurance

This enables the Department to address the wide variety of IS topics across all stages of the systems lifecycle, from requirements definition and process modelling, through systems specification and design, to procurement and post delivery support. In particular, it brings its unrivalled expertise on security, safety and information warfare topics to match the customer's system requirements.

The Department has developed strong relationships with industry, academia and other relevant centres of excellence. These are used to facilitate both spin-in and spin-out of technology and expertise. For example, a number of novel techniques and software tools have been developed in the course of applied research for the MOD in conjunction with both large and SME organisations.

The transfer of such technologies has, and is being, effected by means of a combination of sub-contract and licensing arrangements where this is seen as being of benefit for MOD and UK industry in general.

The Department exhibits at, and attends national and international exhibitions from specialist events such as *Government Computing* in London to *CeBIT* in Hanover, the latter being arguably the industry's major annual exhibition event.

## **Technologies:**

**Information and Knowledge Management:** Research, development and consultancy on Information and Knowledge Management. The work focuses on understanding how to improve the utilisation of information and knowledge available to organisations (either internally or externally). The group is currently working with the Cabinet Office IT Unit and Civil Service College on IM/KM within government; on IM/KM for Joint Battlespace Digitisation; and support to MOD's equipment acquisition process.

**IT Security Healthcheck:** A service to protect IT Systems against illicit operations. The service carries out a practical survey by attempting to penetrate a client's IT System using the same techniques a real adversary would use, thereby showing up any vulnerabilities. The survey provides impartial advice on how to protect the system from penetration, how to increase resistance to technical assault, shows staff how to ensure ongoing protection, and reviews the configuration for points of weakness.

**Information Security - Purple Penelope:** A security demonstrator which shows how multi-level security can work with users, not against them, in an heterogeneous computing environment. It supports domain based security by adding discretionary labels to Microsoft's Windows NT™, creating non-intrusive security analogous to the paper world thereby enabling sensitive data to be handled by existing mainstream software applications. Purple Penelope has been licensed to Argus Systems, and is the subject of a collaboration agreement with TRW, who are exploring the possibility of a product.

**Secure Bastion Firewall:** A demonstrator of firewall technology to provide assured protection for electronic messaging and web traffic between systems and networks operating under different security regimes. It provides E3 level of assurance based on the use of UNIX products.

**BOB:** Where it is necessary to ensure that access to sensitive (private) data is separated from open data (eg via the Internet) it is not possible to rely on the control mechanisms of commercial web servers. Bob is a system which pre-encrypts sensitive information as it is placed on the server and, by using a decryption facility added to the cleared user's browser, positively ensures that the sensitive information can only be accessed by cleared users.

**DINO (Data In Nothing Out):** Reliable one way communication between two systems that guarantees no information can leak in the opposite direction. Based on fibre optic transceivers and UDP communication protocols, DINO provides a low cost, fully automatic system for connecting relatively unprotected or public networks of open data sources such as newsfeeds, E-Mail and database updates to the most sensitive systems.

**Directory Boundary Agent:** Existing X.500 application software is not evaluated so is potentially insecure. With the growth in electronic communication, the need to communicate across domains resident in industry and other government departments means systems cannot be kept isolated. The Boundary Agent is akin to a firewall or guard with configurable directory access controls and a high level of assurance at low cost, allowing systems to be connected to those in different domains whilst protecting data from unauthorised access.

**DELOS™ Open Source Information System:** A flexible and effective open source information management system using hyper-media display techniques to mine data according to the user's defined interests from the "Information Superhighway". The system uses effective search, retrieval and presentation techniques and, working in real-time, embraces internet and world wide web sources, providing a wide range of both on-line and CD-ROM data integrity. DELOS has been licensed to Comax Secure Business Services to provide an open source information system for UK government departments.

**High Integrity System Assurance:** A number of programmes designed to achieve end-user and Certification Authority confidence in critical systems which span the development life-cycle, ie: requirements capture, specification, detailed design and verification. This high integrity hardware and software permits rigorous requirements specification, rapid modelling and prototyping and gives added integrity to commercial software through independent safety critical process assessment.

#### **Capabilities:**

**Information/Knowledge Management:** Advice on Information and Knowledge management concepts, policy, strategy development; support requirements definition; impartial project support; assess product capabilities; effectiveness of IM/KM solutions within organisations.

**Information Security:** Secure electronic directory and messaging technologies; secure Internet and Web technologies; public key infrastructures for system and application security; participation in market-leading security related standards development; secure distributed & mobile object infrastructures; secure access control mechanisms; firewalls.

**Information Warfare:** Research into the defence of critical and HMG systems against deliberate attack using the network, software and hardware means; vulnerability analysis of COTS products; penetration testing; threat assessment and analysis; system behaviour under attack; key information system security reviews; countermeasures; development of strategies and components to support & enhance system security.

**Data Networks & Distributed Technologies:** Naming and addressing for network connectivity and application-specific uses; object based distributed systems using proprietary technologies including CORBA, Java & Active X; networked electronic directories; network protocols such as IPv6; electronic messaging technologies.

#### **System Assurance:**

**Hazard Analysis:** Analysis of a proposed system's integrity against a required standard before development, plus assessment of the likely impact on development of a proposed integrity level.

**Formal Modelling and analysis of software and hardware:** looking for evidence of safety or security properties such as conformance to specification; fault tolerance; freedom from security vulnerabilities; and secure information transfer protocols.

**Post Incident Analysis** - eg member of Ariane V Board of Enquiry.

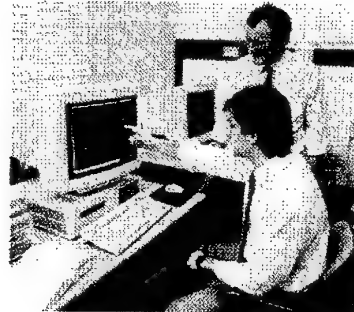
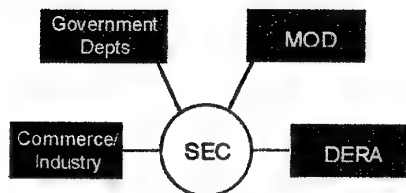
#### **IS Strategies, Technologies and Applications:**

Contract research; programme & project directed consultancy services; trends analysis; IS strategy development through to Command & Information Systems design; specialist skills & experience in interoperability; portability and component-based system design paradigms.

## **SYSTEMS AND SOFTWARE ENGINEERING CENTRE**

**(SEC)**

Software  
Systems  
Consultancy  
Advice  
Standards  
Training



The Systems and Software Engineering Centre is a UK centre of excellence in systems and software engineering. Approximately 200 strong and based in several UK locations, the SEC serves commerce, industry, MOD and Other Government Departments by delivering best practice in Software projects, Consultancy, Training, and Standards.

**RAINBOW TEAMS:** The SEC's suppliers include many of the UK's leading software and systems houses under a 'Rainbow' mechanism, which encourages active participation between the SEC and the UK software industry to undertake joint projects.

By providing a route into DERA, the Rainbow mechanism creates the potential for participating companies to gain business. Conversely, the SEC provides a simple route for DERA software related inventions and expertise to flow out to industry. Examples include: creation of a Java Centre in association with Sun Microsystems Ltd, a Radar pulse analysis tool targeted for the RAF and made available to industry world-wide, and provision of SEC standards for software development to any interested party.

Recognising that there is a shortage of high quality software and systems engineering in the UK, the SEC offers to industry its services and the consultancy/research of DERA. Markets covered include defence, transport, communications, finance and others. The SEC welcomes the opportunity to partner with others to undertake project work.

Also as part of the Rainbow mechanism, the SEC is guided in its strategy by a forum with strong industrial participation.

The SEC's consultancy support to the UK MOD often involves assessing industrial suppliers and, at times, helping them to achieve project success. Similar work is undertaken with Other Government Departments including the Drinking Water Inspectorate and the Highways Agency.

Work with commercial companies has included a major London financial institution, where the SEC provided a high performance database/communications engine at the heart of a global trading system, and a UK electronics company which is receiving advice on Operating Systems.

As part of its Standards remit, the SEC is writing Systems Engineering standards for the ISO, the adoption of which directly improves industry as a whole.

**Technologies:**

**PAT:** Pulse Analysis Toolset - used to extract valuable information from received Radar transmissions.

**AdAPT:** A framework for modelling the performance of radar/sonar arrays with different target and environment characteristics. Useful in designing phased array Radars. This is in the final stages of development but can be sold/adapted now.

**DROMAS:** A simulation/modelling tool primarily for bodies in motion. It is object oriented and contains mapping, 6 degree of freedom modelling and many re-useable components which are extensible. Used for Wargaming, planning, modelling trajectories. eg: missiles, aeroplanes, ships..... Reduces development time and increases quality of models.

**NARIMS:** Nuclear Accident Reporting Information System. A distributed application based on 'Lotus Notes' for monitoring and managing accidents. Available now.

**DOORS:** A requirements capture and management package.

**Process Management Services (SPICE):** A suite of ISO15504 compliant Process Management Products called *Process Professional Portfolio* used to examine an organisation's processes in order to determine their capabilities, including the supply of a quality product, to time and to cost. This provides a means of measuring the capability of the software processes, understanding and managing process orientated risk associated with a particular supplier, a means of determining their own software capability, and a method of managing process improvement.

**Services:**

**Software Projects:** SEC takes on projects, usually of a engineering/scientific/real-time nature. Either fixed price, cost plus, or some form of shared risk nature. The projects tend to be small to medium sized, eg: from £40k to £1M. They tend to follow a highly structured/documented approach.

**Software Support (bodyshop):** The provision to anyone of software engineers, supervised by a SEC manager. Primarily in engineering, and scientific applications.

**Project Support:** Providing advice to procurers of software intensive systems. This is biased towards MOD style procurement and 'traditional' engineering systems procurement and is highly process, procedure and standards oriented. Specific activities include: developing Invitations To Tender, assessing supplier responses, acting as intelligent friend of the customer..... A proven service, available now.

**Systems Engineering:** This has focused on standards development and requirements engineering work with some ad hoc consultancy relying on other services, particularly requirements engineering. An embryonic service, not yet clearly defined with limited delivery capabilities.

**DERA Java Centre:** The DERA Sun Authorised Java Centre is a facility provided by SEC on behalf of DERA to supply knowledge, consultancy, programming, and training skills in Java - a platform independent, proprietary computer language and operating environment. The Centre is available to the whole of DERA, MOD, Other Government Departments and commercial businesses.

**General Consultancy:** In systems and software engineering in areas such as methods, design assessment, general supplier assessment, tools advice. There is also the capacity to advise and help on project management, configuration management, change management & competencies.

**Standards development:** This is a strength and the SEC has standards which are available freely that can be tailor to organisation's needs. We can also develop standards for others. Individuals in SEC have particular knowledge in Software, Systems, Hazard Analysis, SPICE and other standards. Available now.

**'Quality Services'/Auditing:** The title is subject to revision but the focus is on auditing software suppliers and projects against models, notably SPICE and CMM, and against organisation and international standards. Available now.

**Requirements Engineering:** An established service to elicit the requirements for systems projects (not specific to software). The approach is both humanistic and technical and usually uses the DOORS tool to capture and manage the requirements. Available now.

**Safety Critical Systems:** The SEC has the capability of undertaking consultancy in Hazard Analysis and has conducted static code analysis reviews. Available now.

**Research:** Stand alone or collaborative research in the area of software/systems engineering. Recent work has been in: requirements, information management, command agents, & genetic programming.

**Year 2000:** This helps organisations identify software at risk and manage their way through those risks. We evaluate/test legacy software and can often make the changes needed to gain compliance. Tends to focus (though not exclusively) on engineering/scientific applications. Available now.

**IT Development:** The SEC has developed several relatively small IT applications in Microsoft Access and Excel to assist themselves and DERA. Narims (Lotus Notes) is also an example of an IT application and JAVA has strong capabilities in this field. ORACLE is also featuring in a current project. Projects tend to be business and engineering based. Available now.

#### **Training:**

**SCE/CMM training:** Training others in conducting CMM audits (we can also provide audits).

**Software Management Training:** 1 day and 3 day courses for managers and practitioners.

**JAVA, Awareness and detail:** Overview and programmer training.

**Requirements Engineering:** Provides practitioner level training.

**Systems Engineering:** Currently under development.

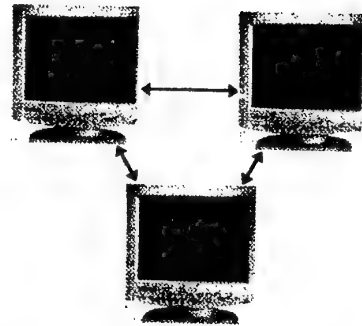
#### **Capabilities:**

Code & Test, Simulation, Project Management, Databases, Safety Critical Scientific Software - eg: algorithm encoding, DERA Java Centre (a SEC Capability and DERA-wide Service), Reverse Engineering Software/Documenting, Re-engineering, Consultancy, Training, Methods & Tools, Acquisition Management, Staff Support (Bodyshopping), Software Productisation, Information Technology (IT), Geographical Information systems (GIS).

## **BUSINESS SYSTEMS DEPARTMENT**

### **Management & Delivery of Internal IS:**

- Desktop Client/Server Applications
- Systems Upgrade & Improvement
- Requirements Analysis
- Business Analysis
- System Design
- Technical Assistance



The principle role of the Business Systems Department is the management and delivery of the internal DERA Information Systems (IS) Programme.

The purpose of the IS Programme is to support the effective internal functioning of DERA by ensuring the delivery of Information Systems that support the business process and the business improvement programme, as determined by the DERA Corporate and Sector customers. Additionally, the Programme provides complimentary Support and Advisory Services as necessary to fulfil the needs of DERA.

The IS Programme is made up of a number of Information and Business related projects authorised by the central DERA Executive Committee (DEC). The department is responsible for the co-ordination, planning, execution and successful delivery these projects, whilst ensuring that there is convergence towards the goal architectures.

The key drivers for the IS Programme are:

- Information Systems Strategy which sets out Information Technology (IT) support requirements for the achievement of DERA business objectives;
- The DERA Critical success Factors;
- Capitalising on the wealth of knowledge and expertise within DERA to realise the potential benefits from the projects;
- Annual Corporate Plans.

**Technologies:**

**Desktop Client/Server and Intranet Applications:** These are being developed and deployed to meet the associated corporate policy requirements.

**Internal Secure Intranet (E-Mail):** The previous *WordPerfect Office* system has recently been successfully replaced with one based on *Microsoft Exchange* with a user population of 10,000. The new system integrates the internal E-Mail system closely with *Microsoft Office*, which is the DERA standard for word-processing, spreadsheet, database and presentation functions.

**Year 2000 Compliance:** A programme is well underway to ensure corporate applications and infrastructure are year 2000 compliant.

**Upgrade of Corporate Operating System:** Migration is underway to upgrade the corporate secure Intranet from 16 bit *Windows* to a 32 bit environment based on *Windows NT* and *Office 97*.

**Accredited Firewall Trial:** A trial is currently underway which will lead to DERA users being able to exchange unclassified E-Mail across the Internet from their terminal on the internal secure Intranet.

**Library Management system:** Disparate local systems have been replaced with an integrated system enabling DERA staff to use a Web Browser to search and order material held by the various DERA Information Centres.

**Purchasing Process:** Improvements to this process are being enabled through the introduction of an Enterprise Resource Planning (ERP) package currently being implemented.

**DERA Knowledge Management System:** This programme is identifying and analysing the Knowledge Management requirements in support of the associated corporate policy.

**Capabilities:**

Programme and Project Management, Business Analysis, Technical Assistance, Requirements Analysis and System Design, Selection and Management of Consultants, and Competitive Procurement of Business Related IT Systems.

The Department has developed strong relationships with its internal customers and suppliers at all levels including DERA's site management contractor, facilities management supplier, and industry - from whom a number of consultants are obtained.

Close working relationships have also been forged with the IS Schedule Management team responsible for the daily operation of the IT systems and physical IT infrastructure under the Facilities Management contract, the Installation Design Authorities, and the Security Advisors to ensure acceptance and integration of new systems into operation within DERA.



## FARNBOROUGH SUPERCOMPUTING CENTRE

Massive Parallel Processing

National Centre for:

- High Performance Computing
- High Performance Programming

Assessments

Demonstrations

Advice & Training

Seminars



The Farnborough Supercomputing Centre (FSC) covers all aspects of supercomputing, providing awareness, assessments, demonstrations and other activities focused towards the best solutions for numerically intensive problems.

The FSC is a collaborative venture by DERA, British Aerospace plc, GEC-Marconi Ltd, Cray Research (UK) Ltd, and others and is one of the five Dual Use Technology Centres set up by DERA to support technology transfer between Industry/Academia and the Ministry of Defence. It provides Government Agencies, Industry and Academia with shared access to one of the most advanced Supercomputing facilities in Europe.

Computer simulation is increasingly being used to solve problems faster and at a lower cost than traditional experimental methods. However, many important scientific and engineering problems are so complex that solving them via numerical simulation requires high performance and visualisation tools which are only available on very powerful computers.

The cost of these 'Supercomputers' is too great for most single organisations to acquire, hence this partnership allows products to be brought onto the market earlier, cheaper, safer and better.

The Centre's objectives are to:

- Reduce the cost to individual members by sharing resources;
- Enable users to increase their competitive performance;
- Create a National Centre for High Performance Computing;
- Create a National Centre of Excellence in High Performance Programming techniques;
- Provide access to new computing technology (Massively Parallel Processing)

**Technologies:**

At the heart of the FSC is a Cray Research T3D Massively Parallel supercomputer with three other Cray Research Vector Supercomputers sharing access as 'front end' systems. The T3D is the most important part of the shared resource with 256 processors and 16 Gbytes of main memory. Its peak performance is 40 Gigafllops - that is 40,000 million floating point operations per second, which is faster than the speed achievable on a conventional vector/parallel supercomputer. Extensive silo storage is available for fast retrieval of information.

DERA staff are available to provide technical and administrative support to users of the Centre. Capabilities are also available to assist with applications programming, advice and training when required. A quarterly Newsletter is distributed to all FSC DERA users and a large quantity of information is available on-line, including a User Guide and Computer Based Training.

The Centre sponsors supercomputing conferences and seminars that provide a forum for exchange of views between international leaders in various scientific fields. Special seminars can be arranged in conjunction with industry sponsors for generic applications such as CFD, CEM, CSM, etc. Convivial facilities are available ranging from an auditorium seating 100, to smaller studio and syndicate rooms. A high standard catering service is also provided at reasonable cost.

**Costs** - The nature of the Supercomputer Centre, and the high performance equipment available, require that the costs be shared. Details are available from the FSC Administrator on 01252 382168. However, no charge is made for on-line data storage, the number of characters input or output, or printing and plotting unless usage of one of these functions clearly becomes excessive. A small charge will be made for the recovery of a data-set lost by User action.

**Capabilities:**

Cray Research T3D - 256 processors, 16 Gbytes of logically shared total memory and 4 I/O gateways. The T3D combines DEC alpha processors capable of 150Mflops peak performance with a very fast bi-directional 3D torus interconnect network which permits peak interprocessor communication rates of 300Mbytes per second in every direction through the torus, allowing extremely fast remote memory access.

Cray Research YMP/C90 - Vector/parallel supercomputer with 4 processors, each capable of a peak performance of 1 billion floating point operations per second and 8 Gigabytes of high speed central memory; >150 Gbytes of disc space for user jobs, plus data migration (1500 on-line storage tape + archive disk file system).

Cray Research J90 - Another vector/parallel supercomputer with 4 processors each capable of 200 million floating point operations per second and 2 Gigabytes of central memory; >30 Gigabytes of disc space for user jobs.

These processors will be upgraded to the more powerful J++ processors in 1998, giving a total processing power of 14 Gigafllops.

**Third Party and Proprietary Software:**

DYNA - used for analysing the large deformation dynamic response of inelastic solids and structures;

GINO - general purpose 3D graphics subroutine library;

NASTRAN - large scale general purpose program that solves engineering analysis problems utilising the finite element method;

NAG - Fortran library containing a comprehensive collection of mathematical and statistical subroutines;

ENSIGHT - distributed, inter-active, post processing tool for finite element engineering visualisation;

FLUENT - general purpose program for modelling fluid flow, heat transfer and mass transfer;

SAUNA - a CFD suite for modelling viscous or inviscid flow about complex aircraft geometries using hybrid structured/unstructured grids;

GRIM - A Eulerian Hydrocode;

MOPAC - Semi-empirical chemistry software for studying ions, molecules and polymers.

Note: Not all programs are currently available to all users because of licensing restrictions, but if there is sufficient interest, suitable licensing arrangements can be made.

## **COMMAND, CONTROL & INTELLIGENCE SYSTEMS**

Command, Control & Information Systems  
Simulation & Development Environments  
Planning & Decision Aids  
Robotic Systems & Remote Control  
Low Cost PC Workstations  
Data Analysis & Reliability Support



Land Systems Sector provides a comprehensive technical capability in all issues relating to the land-based environment, by co-ordinating the research, studies, prototyping and project support activities of a wide range of technologies and equipment from Fighting Vehicles to Command & Control and Radar systems; together with the systems engineering expertise necessary to produce fully integrated solutions.

The sector's expertise and capabilities are aligned into 6 broad categories, each of which forms a separate department:-

- Survivability Systems
- Mission Sustainability Systems
- Vehicle Concepts (covering both systems and concepts)
- Airspace Management
- Intelligence, Surveillance, Target Acquisition and Reconnaissance (ISTAR)
- and
- Land Battle Management

Links with industry operate at a number of levels, ranging from extramural research placed on industry by DERA, through sub-contract research and consultancy placed on DERA by industry, to Strategic Alliances with several key defence companies.

The Sector's aim is to foster relationships which enable the technology developed within Land Systems as part of the work for MOD to be transferred to UK industry in order to give them a competitive advantage in their particular field, thereby maximising the benefit to the UK from the government's research investment.

## **Technologies:**

**GSCDE:** Generic Strategic Command & Information Systems Development Environment - In a rapidly changing world, the need for flexible and effective Command & Information Systems (CIS) is paramount. Many current systems were developed in isolation with little integration between them. To satisfy the need for a coherent CIS infrastructure, research is investigating a flexible CIS environment aimed at providing a flexible assessment of Command, Control & Intelligence (C<sup>2</sup>I) products and architectures which might be of potential use to MOD, and to maintain an awareness and understanding of the current and emerging technologies in the Commercial Off The shelf (COTS) marketplace.

**UKINCA:** Research having twin goals: the realisation of a common distributed database, and the means for distributed production. A testbed provides a platform on which enterprise information services may be modelled, comprising a heterogeneous computing environment, including UNIX and NT servers, each of the popular client workstation types, and distribution across local area networks interworked using a common backbone.

A twin track approach has been adopted aimed at the definition of an appropriate architectural model, underpinned by practical prototyping activities using the multi-node testbed. Drawing on leading edge technologies from the commercial sector, key facets of emerging technologies have been validated.

**Land Platform Simulation:** Distributed simulation, employing open standards provides a modular, extensible simulation architecture allowing a full representation of the battlefield environment. The Team provides a complete simulation capability to meet the full range of requirements, including training; mission rehearsal; research; and concept development.

The use of wide area networking allows applications at widely dispersed sites to be brought together to participate in joint exercises using a shared virtual environment. Research includes Virtual Prototyping - providing virtual representation of real equipment including virtual Man-Machine Interface (MMI) devices, and Immersive Virtual Reality Techniques - providing a full 3-D virtual representation of vehicle interiors as well as the outside world. Work on computer generated forces includes maximising their integration with manned simulators and methods for the representation and incorporation of valid behaviours, including synthesised speech reports from computer generated entities.

**STOW:** Synthetic Theater of War - Part of the Advanced Distributed Simulation (ADS) programme of the US Defense Advanced Research Project Agency. STOW aims to radically improve the cost effectiveness of distributed simulation systems through the development and application of novel technologies by creating a seamless simulated environment useable across a wide range of training, operational, procurement, and policy development applications. The UK defence Synthetic Environments (SE) programme supports an awareness initiative to educate UK stakeholders; the development of an investment strategy; a programme of national Capability Demonstrators; plus participation in various STOW related programmes.

**Digitisation of the Battlefield:** As technical lead in support to the Digitisation of the Battlespace (Land) Programme, the Land Battle Management Department provides independent expertise on C<sup>3</sup>I systems including: systems integration, assessment, IS infrastructure and mission applications. The programme is supported by research in simulation, training and intelligence systems. Key capabilities are Army and Joint CIS architectures, use of generic tools and techniques, command and human systems, simulation and training, data fusion and information selection and dissemination. Hardware and software tools for communications monitoring have been developed and are widely used to gather data in laboratory and field conditions.

**Emergency Planning & Response:** This Demonstrator shows how advanced planning aids can assist an emergency planner in developing robust and consistent contingency plans with greater accuracy, and in simulating the consequences of their planning decisions. It supports integrated gold, silver and bronze incident command; facilitates audit and investigation of incidents and responses; supports training and lessons learned from past incidents; provides dynamic replanning in response to changing situations; simulates emergency planning decisions; and provides Web and Artificial Intelligence (AI) planning technology on a PC. DERA is actively seeking to transfer this technology to a software vendor.

**Data Analysis & Reliability Support (DARS):** The multi-discipline DARS team have over 25 years practical experience in data collection and the application of reliability & maintainability (R&M) and costing techniques on military equipment which is now available to both the military and civil sectors. The Trails Analysis and Reliability Database Information System (TARDIS) contains over a million equipment records and forms the basis of the DARS concept prediction and evaluation service.

**Athena:** Ballistic Missile Defence Command & Control (C<sup>2</sup>) Demonstrator - A workstation to aid BMC C<sup>2</sup>, developed through operator evaluation by serving officers of the UK and USA forces. Aimed at ensuring deployment of the most appropriate theatre weapons systems, and maximising their effectiveness by integrated operation of all available resources. The core capability equips operators with a broad range of decision aids, relative to theatre BMC C<sup>2</sup>, which simplifies the weapons allocation task in a time critical activity. Additionally, Athena offers wargaming simulation and training facilities. The expertise used to develop Athena is available to government and industrial organisations in the form of research or consultancy services.

**Low Cost PC Workstation:** The measurement of height, speed and distance from video pictures has its roots in many applications. DERA has developed a low cost, multi-standard, Pentium based PC station capable of replaying video images with an in-built toolset which can be used to carry out accurate mensuration functions. Being Windows™ based, the system is easy to use and provides accurate, repeatable answers to on-screen measurement problems.

**Low Cost PC Workstation for Image Processing:** A Windows™ PC based workstation capable of replaying full colour broadcast standard images. The system can display two video streams simultaneously, which means that both optical and thermal images can be displayed on the same monitor. A flexible toolset provides fast & reliable manipulation of images which can be tailored to specific needs such as high speed to single frame control, distance height and speed measurement, stopwatch and zoom.

**Robotic Systems & Remote Control:** DERA teams in Robotic Systems, Remote Control and Intelligent Control are pursuing an active research programme into technologies and applications for unmanned vehicles which has produced a range of specially designed small wheeled and tracked vehicles through to a tele-operation kit for a main battletank, all of which can act as testbeds for further research and experimentation. Specific demonstrators include:

**HARP - Hybrid Automotive Research Platform:** demonstrating how both petrol and electric drives can be combined to give a small unmanned vehicle the advantage of ease of control from an electric drive, with high endurance from a combustion engine.

**CARLOS -** a robust fire fighting system which can be used in applications including surveying a fire; chemical hazards; remote hose laying; and the deployment of thermal imagers or other sensors, thereby reducing the risk to fire fighters. Carlos can drag up to 50m of charged fire hose and all standard attachments can be fitted.

**SURVEILLANCE POD -** developed to show how remote observation duties for reconnaissance or artillery spotting can be carried out by an unmanned vehicle. It comprises a very small tracked vehicle carrying an extensible mast and cameras, giving remarkable mobility and stealth.

**DRIFT - Driving Remotely In Following Truck:** embodies the concept of a rapid-fit conversion kit for existing logistics vehicles allowing the lead truck to be controlled via a constant tension cable from the following vehicle, displacing the crew to a safer position.

**DRAWSTRING GRIPPER -** Patented, simple, yet remarkably versatile device which could be used for a variety of remote lifting tasks including goods, but also the recovery of unconscious people or animals.

**AVRE - Armoured Vehicle Royal Engineers:** a tele-operation kit for the Chieftain tank, produced to assist in mine clearing, which enabling a remote operator to control driving, ploughing and fascine functions using a radio link from up to 2km distance.

**Capabilities:**

**GSCDE:** Representative CIS environment, consisting of a heterogeneous client/server multiple-protocol architecture, plus various types of hardware platform, multiple operating systems and application suites, together with several different communications media. Measurement of performance of military communications systems; decision support aid assessment; integration of new and existing C<sup>2</sup>I CIS; client/server architecture and applications integration. The GSCDE is constantly being updated and is equally applicable to military and civilian needs.

**UKINCA:** Testbed incorporating three-tier client/server architecture; cascaded databases modelling scalability for enterprise-wide solutions; interface to a common information web implementing WWW technology; transparent access to information including: geographical transparency; structured data support; vendor independence; multi-media support; flexible information, navigation and retrieval; direct, on-line publishing; intelligence push & pull; collaborative services.

**Land Platform Simulation:** Distributed simulation; virtual reality; virtual prototyping; networking; database modelling; image generation; computer generated forces; interoperability; standards.

**STOW:** Improved environmental models; introduction of the human dimension; operational & equipment concepts; ATM multicast communications systems.

**Digitisation of the Battlespace:** Analytical skills to determine the requirements of C<sup>2</sup> applications from doctrinal information, and the architecture necessary to enable applications to act as a coherent system. Practical skills to develop C<sup>2</sup> applications in support of operational, intelligence and combat support functions in both land and joint warfare domains.

**Emergency Planning & Response:** Generation of new contingency plans; updating plans for new situations; testing plans on alternative scenarios; auditing for government regulations.

**DARS:** Requirements & programmes; analysis & predictions; trials design & analysis; concept & tender bid assessment; reliability centred maintenance; project risk management; qualitative & quantitative assessment; whole-life costing including COEIA, acquisition and ownership costs; safety case modelling & evaluation; safety assessment.

**Athena:** Decision making support, including: planning; threat assessment; target allocation; weapon assignment; weapon control; kill assessment & operational analysis; wargaming and training.

**Low cost PC Work Stations:** Zoom; odd/even field; full frame; image rotation; distance measurement; distance comparison; height measurement; aspect ratio measurement; speed calculation; stopwatch; colour filtering;

**Robotic Systems & Remote Control:** Communications; control; remote driving; vehicle intelligence; broad system integration capabilities.

## **AIRSPACE MANAGEMENT SYSTEMS DEPARTMENT**

Secondary Surveillance Radar  
Radar Test Facilities  
Radar Processing Facilities  
Airborne Collision Avoidance Systems  
Computer Assistance Tools  
Human Factors



The Airspace Management Systems Department is situated at Malvern. About 150 scientists and engineers undertake a programme of research and project support which addresses the development of both military and civil airspace management and air command and control systems.

Whilst most work is carried out for the military customer, a significant proportion is undertaken for the UK National Air Traffic Services. The teams exploit synergies between the military and civil programmes and undertake a wide range of activities in close collaboration with Industry.

The Department is organised into 6 capability areas:

The Air Systems Assessment and Simulation Group: provides a focus for systems thinking and research to support the development of Air C<sup>3</sup>I systems.

The Air C<sup>3</sup>I Support Group: carries out work in two main areas, research and project support; giving technical and systems advice mainly to the operational requirement branches and procurement executive of MOD.

The Air Traffic Control Systems Group: carries out R&D on civil ATC Systems for, amongst others, Eurocontrol, the European Commission and UK National Air Traffic Services Ltd.

The Extended Air Defence Modelling Infrastructure and Ballistic Missile Defence Group: provide a capability covering radar technology, target identification, and communications requirements through to command and control.

The Battlefield Air Defence and Identification Group: addresses ground based air defence across all functionalities relating to air target identification systems in a Tri-Service context.

The Battlefield Air Defence Project Support Group: is the focus for providing pan-DERA technical advice on military systems from feasibility studies, through development, in service, to mid-life updates.



## **Technologies:**

**Mode S Secondary Surveillance Radar:** Civil Air Traffic Control (ATC) relies heavily on SSR to provide controllers with information on aircraft positions in three dimensions and their "Mode A" identification code. This system represents the next generation SSR for civil ATC. Based on an original proposal and research by DERA, the ongoing work is contracted by the National Air Traffic Services Ltd (NATS).

**Secondary Surveillance Radar Test Facilities:** A set of facilities to test Mode S equipment to: check compatibility with standards, to investigate anomalies and recommend remedial action; to model, assess, and investigate the effects of various systems on other equipment in the crowded SSR/IFF bandwidth; and to test SSR transponders which, because they operate in a number of different modes, can cause mutual interference.

**Radar Data Processing:** ATC systems have become increasingly dependent upon radar data processing. DERA is engaged in research into advanced tracking techniques for the ATC environment and has facilities for recording live data for subsequent analysis; for simulations; and for producing new processing algorithms. The facility includes monopulse plot extractor specification & design; radar performance analysis; multi-radar tracking; tracker optimisation; RDP simulation and development of Short Term Conflict Alert (STCA).

**Airborne Collision Avoidance Systems:** ACAS is a safety system of last resort which requires immediate action by the pilot. However, unnecessary alerts can cause disruption to air traffic systems. DERA offers expertise in collision avoidance systems; comprehensive analysis tools; and support for ICAO standardisation.

**Computer Assistance Tools:** The current Air Traffic Management System is reaching its limit. The use of computer assistance tools will greatly increase this capacity. DERA has extensive experience in developing such systems; their prototyping; and evaluation in realistic simulated environments, including: approach/departure sequencing; active traffic management; trajectory prediction; conflict probing; flight path monitoring; and negotiation management.

**Human Factors:** Increased automation and computer assistance for the controller require detailed and extensive evaluation of displays and interfaces. Real-time simulation facilities are available for medium scale prototyping of ideas; whilst DERA's experience in Human Factors and the design of complex human-machine systems includes real-time simulation; input devices and interaction techniques; human performance measurement; automation and the role of the human; human computer interface design; prototyping and evaluation.

## **Capabilities:**

Real-time simulation facilities including:

FLAME (Flexible Airspace Modelling Environment) - enabling ATM concepts to be studied over really large geographical areas eg: whole of Europe;

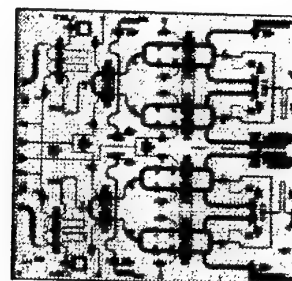
RAFT (Real-time Air Traffic Control Facility Test-bed) Prototyping - of operational concepts, specifications and designs before assessment with fully-manned real-time simulation, Configuration - using real-time script driven production of traffic with selectable characteristics for required controller presentation; Displays - with interactive plan view display windows to display tracks on a background map and the entry of flight data and control; Aircraft models - adjustable by type describing the flight envelope and trajectory specification to define basic manoeuvre behaviour; Sectorisation - flight through multiple sectors, electronic co-ordination and handover and random response delays.

Architectural prototyping; very high resolution ATC workstations; Rational Toolset to aid rapid development of ISO 9000 compliant software including: APEX - code development environment for C, C++, ADA 83 and ADA 95; ROSE - object oriented design tool supporting Booch, OMT and Unified methodologies; SoDA - Software Document Automation Tool; TESTMATE - automated development, management, execution and analysis of functional and structural software test.



## **ELECTRONICS - RESEARCH & DEVELOPMENT**

Electronic Materials and Devices  
Optical Materials and Devices  
Microstructures & Microsystems  
Photonics  
Lasers  
Imaging Sensors  
Displays



Transforming visionary ideas into commercial products is often dependent on long-term research providing a new technology. Most of the Electronics Sector's work is research into new materials and devices which, although mainly undertaken for military purposes, has potential applications across a variety of civil markets, including automotive, electronic components, process control, medical information systems, communications, entertainment and others.

The Electronics Sector works closely with industry and academia, often in confidence with microelectronic companies, resulting in dual use research offering shorter timescales, reduced costs and lower risks to both the MOD and commercial organisations alike.

### ***Research Topics appropriate for commercial exploitation include:***

- **Electronic materials, devices and technologies**
  - Narrow gap semiconductors for low power, high performance applications
  - III-V epitaxy processes for opto-electronic devices
  - Si/SiGe devices
  - High temperature Superconductor thin film devices
  - Silicon on Insulator
  - Monolithic Microwave Integrated Circuits (MMICs)
  - Magnetic materials, thin film structures and devices
  - Materials growth techniques - MBE, MOVPE, CBE, CVD
  - Silicon processes and characterisation
- **Imaging sensors**
  - Imaging sensor arrays
  - Focal plane image processing
  - Imaging system design
  - Imaging through condensed media
- **Displays**
  - Liquid crystal technology
  - 3-D displays
  - Porous silicon light emitters - tuneable colour
  - Electroluminescence materials and devices
  - Man Machine Interface
- **Surface Modelling, Characterisation and Modification**
  - Novel pigments
  - Modelling and measurement of complex surfaces
  - Complex thin film structures
  - Coating techniques and processes
- **Optical and Photonic materials, devices and technologies**
  - Diffractive optics and Holography
  - Integrated and waveguide optics
  - Optical signal processing
  - Opto-electronic Integrated Circuits
  - Optical Interconnects
  - Non-linear optical materials
  - Optical and hard, protective coatings
  - Light emitting silicon
  - Scattering phenomena and propagation
  - Quantum optics
- **Non Imaging sensors and systems**
  - Microsystems; Integrated and smart microprocessors
  - Embedded sensors
  - Optical fibre sensors
  - Magnetic, acceleration, position, gas and particulate sensors, etc
- **Signal Processing**
  - Pattern and information processing
  - Image processing and interpretation
  - Parallel processing
  - DSP techniques
  - Speech technology
- **Lasers and Applications**
  - Solid state, gas and semiconductor laser design, fabrication and testing
  - Laser-materials interactions
  - Laser applications - sensors, radar, high power, optical data processing, communications

## **Technologies:**

**Electronic & Optical Materials and Devices:** The performance of electronic components is constantly being challenged by the need for miniaturisation, lower power consumption, higher operating speeds and extended lifetime. DERA is a world-centre of excellence in the research and development of electronic & optical materials and device applications, possessing a unique blend of theoretical and experimental expertise backed by comprehensive state of the art facilities. Our research seeks to extend the capability of conventional electronic & optical materials and device concepts from materials growth and characterisation through device modelling and fabrication to component and subsystem integration.

**Characterisation:** Working closely and in confidence with microelectronics companies and material suppliers, DERA has experience of an extremely wide range of materials, processes and characterisation techniques backed up by state of the art equipment and techniques, including: X-ray diffraction and topography; Scanning electron microscopy; Transmission electron microscopy; Secondary ion mass spectrometry; and Atomic force microscopy.

**High Speed Devices:** High speed solid state devices operating at microwave and millimetric-wave frequencies are key components for many systems including mobile and satellite communications, Radar and automotive products. The High Speed Group works closely with industry and academia in the fields of GaAs Microwave Integrated Circuits (MMICs); On-wafer testing of MMICs to 11GHz; High power GaAs Heterojunction Bipolar Transistors (HBTs); Opto-electronic devices and circuits, waveguides and integrated circuits; High temperature superconducting filters; Component failure analysis; and Novel devices & materials (GaN, SiGe and InSb).

**Displays:** An internationally-acknowledged wealth of expertise and innovation is founded on pioneering breakthroughs in liquid crystal technology in the fields of Cyanobiphenyls and Defect free twisted nematic liquid crystals, including the invention of super-twisted nematic liquid crystal displays (LCDs); Other technologies include High resolution ferroelectric liquid crystal materials including ferroelectric liquid crystal polymers; Fabrication and addressing; Bistable nematic liquid crystals; Novel materials and molecular engineering; and 3-D display technologies.

**Silicon Based Microsystems:** Research into new silicon based microtransducers (sensors and actuators), integrated with suitable signal processing and conditioning electronics, used for motion and position sensing, environment monitoring, and structural health monitoring. A range of collaborative research programmes with industry and academia is supported by a dedicated clean-room laboratory housing a comprehensive range of processing and fabricating equipment.

Silicon Structures: Using micromachining techniques, silicon transducers can be made to respond to: Acceleration; Heat; Pressure; Light; Chemical; and Electrical stimuli.

Mechanical Structures: Accelerometers; Gyroscopes; Steerable micro-mirrors for Spatial Light Modulators (SLMs); and Acoustic sensors.

Microheaters: Infra-red emitters for IR scene projection; Gas sensors; Flow meters; Vacuum sensors.

Microsystems: The integration of microtransducers with electronic circuits increases functionality through on-chip data processing (eg temperature compensation); data acquisition and on-chip data reduction; and Reduced communication bandwidth requirements.

**Photonics:** The rapid growth of the Information Society is placing enormous demands on the performance of systems requiring component performances far higher than are currently available. Photonics technology is enabling radical changes in the ways that information is managed - from data acquisition and communication through data storage and processing to display. DERA has considerable, vertically integrated capabilities from materials growth and device fabrication through to system integration, which facilitates research and provision of materials, devices and systems to give very broad bandwidth, secure optical data communications; fast access, mass data storage media and systems; high performance signal processing and computing; imaging and other advanced sensors; plus high information content 2-D and 3-D video displays.

**Photonics Technology:** The use of fibre optics and opto-electronic components can not only lead to space and weight savings, but also to high speed data transfer (Giga bits) and immunity from Electronic Warfare threats (EW/EMP). DERA expertise covers the range from fibre optic subsystems to state of the art discrete devices. This capability is used primarily to provide prototype 'proof of principle' demonstrators covering: Photonics applications; Wide-band Radar; LIDAR; Neural networks; Delay lines; A/D and D/A converters; Pattern recognition; Opto-electronic integrated circuits; Signal generators; and Fast, wide bandwidth spectrum analysers.

**Lasers & Applications:** Laser technology is used in many advanced systems, including; Remote sensing; Optical communications; Imaging, and Scattering media. 25 years experience exists in high power laser systems, and more recently in novel optical materials and laser sources from the visible to the infra-red. Uses include: Target illumination with pinpoint accuracy; Measurement of particles in the air; Chemical contaminants, and Wind patterns.

**Laser sources:** A range of technologies provide sources across the visible, mid and far infra-red. Emphasis is placed on tuneable, compact, solid state laser technologies as well as high power gas lasers for military and civil applications.

**Laser Sensing:** World-leading expertise has been established in coherent CW Lidar systems based on carbon dioxide laser technology. This has led to a detailed understanding of civil aircraft wake vortex structures which offers considerable commercial potential in enhancing safety in air traffic control and improved aircraft design. The same basic technology can be used to improve the accuracy of ballistic missiles, remote chemical sensing, atmospheric monitoring and collision avoidance in automotive and marine transport.

**Enhance Imaging:** The performance of imaging sensors is often limited by cloud, smoke & particulates, and other background optical signals. Based on many years work in light propagation and quantum optics, a wide range of techniques are employed to reduce these effects including coherent laser detection, polarisation techniques, image processing and Doppler discrimination.

**Optical Materials:** Crystal growth techniques including Czochraiski and Bridgeman, are backed by a wide range of processing and analysis methods. Inorganic crystals for solid state laser sources have been developed for the near infra-red as well as organic matrices for solid dye Lasers. Photo-refractive and nonlinear optical materials such as lithium niobate are used for frequency conversion and optical switching. Recent major investment in bulk optical materials growth has resulted in a state of the art capability.

**Imaging Sensors:** Research is conducted over all parts of the electromagnetic spectrum with the aim of increasing the capability and decreasing the cost of ownership of imaging sensor systems, including:

**Modelling of Imaging Sensors:** Considerable understanding of the underlying process of image information, including the emissivity and reflectivity of objects; propagation characteristics of radiation; interaction of radiation with optical materials and detectors; Image process and display methods. 'Emirald' is available to simulate multi-waveband imaging sensors for rapidly prototyping any imaging sensor, whilst 'Infracal™' is available to calibrate radiometric analysis of infra-red images.

**High Performance Infra-red Sensors:** The increased functionality of smart detector arrays offers significant advantages to image system designers. Research has demonstrated that long linear detector arrays can be used with simple scanning mechanisms to provide high performance, wide field of view imaging, whereas two dimensional arrays provide high sensitivity systems which require no scanning. Working closely with industry, the ability has been demonstrated to design and fabricate hybrid photon detector arrays up to 768 x 12 or 128 x 128 elements. To achieve large affordable arrays, the growth of detector material directly onto silicon has been shown as feasible, whilst analogue silicon circuitry for 'retinal' processing has also been demonstrated.

**Uncooled Thermal Imaging:** In applications where weight, size and logistical support are a major factor, these detectors offer significant advantages over low/medium performance imaging sensors. Research in a number of technologies includes a pre-prepared detector matrix of ferroelectric elements bonded to a silicon read-out circuit. Working with GEC, a 100 x 100 array is now commercially available, a 128 x 256 array is in pilot production and a bolometer array up to 384 x 288 elements has been realised. Work is progressing on yield and costs issues which will enable thermal imaging to be considered in a much wider range of applications.

**Passive Millimetric Imaging:** Aided by novel signal processing techniques developed at DERA, mm-wave imagers can produce images of almost photographic quality. Ongoing research into real-time imaging will ultimately make passive imagers an alternative to Radar for a number of applications; providing surveillance in all weathers, better spatial resolution than concentric Radar systems; and up to 30 times the range of current thermal detection in bad weather. Potential uses include: security scanning in airports, marine navigation sensors, and minefield detection. Images from a prototype 94GHz Imager called 'MITRE', produced by TME to DERA specifications, are internationally accepted as leading-edge demonstrations of the technique.

**Infra-red Detector Research:** Atmospheric attenuation limits the use of the electromagnetic spectrum for infra-red imaging to two regions corresponding to peak emissions from bodies around 1000°C and room temperature. Photon detectors offer the highest performance in these regions but uncooled thermal detectors can offer significant advantages. Research into new materials and devices is providing prospects for better detectors in these regions as well as simpler, more affordable sensor systems.

#### **Capabilities:**

**Electronic Materials and Devices:** 400m<sup>2</sup> silicon processing facility; Epitaxy reactors for semiconductor growth; Bulk crystal growth for novel lattice-matched substrates; Deposition of superconducting and magnetic thin films; Materials characterisation featuring SEM, TEM, AFM, SIMS and DXRD; MMIC design and on-wafer testing; Component testing; Fault tracing using e-beam probing.

**Characterisation: X-ray Diffraction and Topography:** BEDE D3 Triple Axis Diffractometer, BEDE Lang Camera, SIEMENS D5000 Diffractometer. 100mm specimen diameter rotating anode source (Cu, Cr, Mo); High precision lattice parameter measurement; Reciprocal space maps; Double crystal rocking curves; Double crystal and Lang topography (1µm resolution).

**Scanning Electron Microscopy:** JEOL 6400F FESEM, JEOL 6300 and 6100 SEMs, JEOL 8600 Microprobe. High resolution imaging; X-ray microanalysis; Electron beam induced current imaging; scanning cathodoluminescent (visible and IR).

**Transmission Electron Microscopy:** JEOL 4000EX 400keV TEM. High resolution microstructure and defect studies; Lattice imaging; Local elemental analysis EELS/X-ray (10nm resolution).

**Secondary Ion Mass Spectrometry:** CAMECA IMS 3F and 4F. Thin film composition/impurity profile; Sub-ppm sensitivity; 2nm depth resolution; sub-µm resolution SIMS imaging.

**Atomic Force Microscopy:** DIGITAL INSTRUMENTS DIMENSION 3000 MULTI MODE AFM. 200nm specimen size; surface metrology (0.1nm Z, 5nm XY resolution); Phase/friction/stiffness imaging; Magnetic and electric force imaging.

**High speed Devices:** MBE and MOVPE growth of device heterostructures in GaAs/AlGaAs, InSb, SiGe and GaN materials; Full materials characterisation facilities; Device fabrication including optical photolithography to 1µm resolution and dry etching with end-point detection; Fast turn-around hybrid prototyping; workstations and full range of software for design and modelling of MMICs and components; Pulsed and CW power scalar assessment to 50GHz; On-wafer automated probing S-parameter system to 110GHz; NAMAS-accredited metrology and calibration facilities; Component and circuit failure investigation; Performance verification, and Real-time imaging using e-beam prober.

**Displays:** High resolution Ferroelectric liquid crystal displays; Ferroelectric liquid crystal polymers; Bistable nematic liquid crystal; 3-D Display technologies; Research and development for specific solutions; Cyanobiphenyls; TN Alignment; TN multiplexing; Supertwist display; Video-rate Ferroelectric displays; Ultra-high resolution displays.

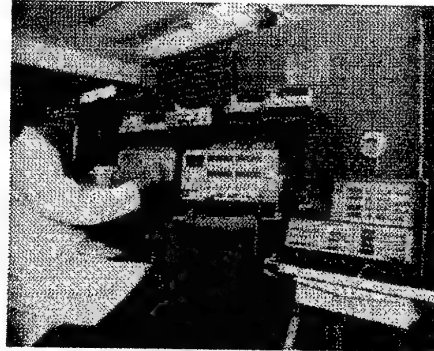
**Silicon Based Microsystems:** Circuit design and layout; Discrete device SPICE modelling with associated parameter extraction; Sophisticated 2-D process and device simulation; 3-D finite element structural and thermal simulation; Bulk micromachining - etching of single crystal silicon using dopant concentration and crystal properties to define structures; Surface micromachining - removal of deposited sacrificial layer to leave microstructures; Microheaters (use of micromachining to control heat loss); Mechanical structures - bridges, beams and membranes;

**Lasers & Applications:** Theoretical and practical expertise in Laser sources and coherent radiation; Vertical integration from novel optical materials through laser systems; Wide spectral coverage from visible to far infra-red; Tuneable Laser sources in the far and mid infra-red; Optical crystal growth; Hollow waveguide optical integrated laser systems; Nonlinear optics and interactions of laser materials; Integrated optical systems for optical communications; Imaging through scattered media; Phase conjunction for adaptive pointing, Laser beam profiling and high power delivery; Compact, remote vibrometry, wind sensing and wake vortex systems; Real-time sensor signal processing; Passive polarisation-enhanced imaging; Fully qualified laser range facility for test and evaluation under real life condition.

**Imaging Sensors:** Innovative detector materials and structures; High Performance infra-red detectors; silicon-germanium monolithic infra-red detector arrays; Low-cost thermal detectors; Thermal imaging in the infra-red and millimetre-wave region; Optical materials and hard, protective coatings; Cooling engines; 'Solar-blind' ultraviolet sensor technology; Imaging system design; Image capture across the spectrum; Scattering & propagation phenomena; Propagation through real media; Imaging through turbid media; Imaging system performance modelling; Diffractive, adaptive and holographic optics; Focal plane image processing; Simulation and modelling of scenes and sensors; Test and calibration of components and whole systems.

## ELECTRONICS - WHOLE LIFE SUPPORT DEPARTMENT

Standards & Measurement Service  
Environmental Testing  
Special Test Equipment Service  
Electronic Systems Testing & Advice  
Components Database & Advice  
EMC Quality Assurance Testing



### **Technologies:**

**Metrology Standards & Measurement Services:** A comprehensive metrology and calibration service disseminating traceable electrical standards to a wide range of government and commercial clients; Expert consultancy and technical guidance on measurements, instrumentation and formal quality issues; A tailored package of standards, calibration, quality auditing and equipment support - all backed by the most extensive NAMAS accredited laboratories anywhere in the UK.

The service provides NAMAS/ISO9001 accredited facilities for electrical, optical, acoustic and free-field measurements; Acts as the Tri-Services' electrical standards centre for traceable and secure electrical measurements from DC to 110GHz; UK National standards for Laser noise characterisation (RIN & CHIRP); Optical and electro-optical measurements laboratory; and Anechoically screened facility for EMC and free-field measurements.

**Special Test Equipment Engineering Services:** The STEE provides independent advice on equipment specification; calibration; maintenance and equipment assessment, both on and off-site, backed by the Defence Metrology Service, of which the STEE is a part.

**Environmental Testing:** A comprehensive range of test facilities is provided for both climatic and dynamic evaluation. Both equipment and packing materials can be subjected to the most demanding sequence of DEF-STAN, MIL, BS and ISO standards which simulate the physical and climatic extremes. Facilities include Vibration and shock testing; total package integrity; Hazardous goods; Complete equipment evaluation; and Climate and atmospheric performance.

**EMC Quality Assurance Laboratory:** A secure and independent centre providing an examination service on Electromagnetic Compatibility (EMC) for electrical and electronic equipment. Holding full UKAS (formerly NAMAS) accreditation, the service tests military equipment for all three Services to all issues of DEF-STAN 59-41. In addition, a fully mobile vehicle is available for off-site electromagnetic spectral surveys. The service includes Impartial EMC consultancy eg: CPS (Cardinal Point specification); Fully trained EMC engineers; Automated EMC testing techniques; and DTI & NAMAS assessment of commercial EMC test houses.



**Electronic Systems Testing & Evaluation:** Provision of technical advice and support on quality related matters in the fields of electronic, electro-mechanical, electro- and visual-optical equipment for the Ministry of Defence, public and commercial sectors. Services include Assessment and evaluation of equipment including development, prototype and production phases; Evaluation of technical specifications; Assistance in the development of defence and national standards; Calibration and testing of instruments and systems in line with health and safety regulations and formal quality requirements; Defect investigation and the development of test criteria and procedures.

**Professional Component Services:** PCS is an equipment support section specialising in electronic components. Services provided include: EPIC2000 - a comprehensive database of electronic parts designed by component engineers to assist design. It includes data from civil and military products from all regions of the globe; ITOM (Integrated Technology Obsolescence Manager) - a powerful desktop tool which gives equipment managers immediate visibility of the impact of diminishing manufacturer source. Using a familiar Windows™ interface it can provide an analysis focused at any level of indenture from both an individual platform or across an entire fleet; Asset Management - The identification, cataloguing and recording of assets as part of management control, using a user friendly database tool that identifies the ownership, gives the location of each item and its calibration status; Product Information and management support - the writing of specifications for procurement, vetting of tender requirements, assessing of bids, and provision of evaluation reports; Subscription service enabling customers to raise queries by phone, fax or E-Mail.

#### **Capabilities:**

##### **Metrology Standards & Measurement Services:**

Acoustics: Sound pressure level, sound intensity, free-field sensitivity; Angle: Synchro and resolver; Attenuation: DC to 110GHz, coaxial and waveguide devices; Capacitance: 2, 3 & 4 terminal devices, dissipation factor, loss, non-standard devices; Conductance: 2, 3 & 4 terminal devices, residual shunt susceptance; Current: DC to 1kHz, 1pA -1kA, AC/DC transfer devices up to 20kHz; Distortion: signal levels from 0.05-300V up to 500kHz; Frequency: Uncertainty to 5 parts in  $10^{12}$ ; Harmonic content: signal generator characterisation; Humidity: Environmental applications; Impedance: Calibration & verification kits; Inductance: Self & mutual inductance, coil characterisation; Magnetic flux: axial & transverse fields up to 0.3 and 5 Tesla respectively; Modulation: index, frequency deviation, measurements up to 22 GHz; Electrical Noise: ENR, Noise figure, factor and effective temperature in coax and waveguide; Phase Angle: 2 channel sine wave forms of different amplitude; Power: up to 50kW at low frequency, coax and waveguide to 110GHz; Pulse: Rise/fall time, rep rate, width, amplitude, aberrations, duty cycle and DC offset; Pulsed High Voltage: peak voltage up to 125kV (0.4%); Q Factor: Q of RF and standard coils and transmission type cavities up to 40GHz; Ratio DC and LF: DC and AC voltage and DC resistance; Reflection Coefficient: Complex measurements in coax and waveguide to 110GHz; Resistance: DC & LF from  $10\mu\Omega$  to  $110T\Omega$  up to 1000V & 1000A; Temperature: For controlled environment monitors; Voltage: up to 100KV DC to 1GHz and AC/DC transfer devices; VSWR: Coax and waveguide to 110GHz.

**Environmental Testing:** to DEF-STAN, MIL, BS & ISO standards:-

Shock: 0.95m x 0.95m; Bump: 0.6m x 0.6m; Vibration: DC-5,000Hz; Acceleration: 50kg & 200g; Dangerous goods (UN Chapter 9 series);

Wheeled vehicle and transport simulation;

Full wet, dry and dynamic evaluation: -60C to +100C; RH to 99%; Altitude to 100,000 feet; Rapid decompression; Salt mist; Drip; Driving rain; Water ingress; Compass safe distance.

**EMC Quality Assurance Laboratory:** Anachoically lined screened enclosures or test cells up to 3.0m x 1.5m x 1.5m, up to 500kg - Diesel and petrol appliances tested within the cells;

Standards: DEF-STAN 59-41; MIL-STD 461/462, BS3G100 Pts 3&4, MVEE 595, EN 55022;

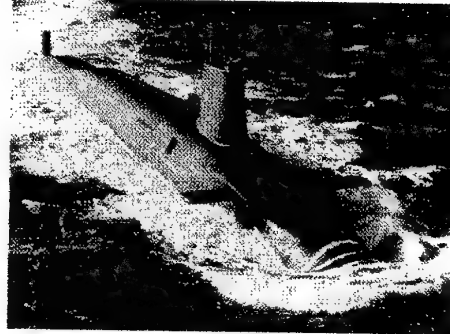
Power supplies: 115/240V 50Hz 1Ø; 415V 50Hz 3Ø; 115V/220V 400Hz; DC to 60A;

Sweep frequency: 20Hz to 18GHz;

Test plans: to meet customer's requirements can be accommodated.

## **UNDERWATER SENSORS AND OCEANOGRAPHY**

Oceanography & Remote Sensing  
Active & Passive Transducers  
Towed Arrays  
Sonar Processing & Displays  
Environmental Assessment



The Underwater Sensors and Oceanography Department employs scientists and engineers in research, project support, trials and evaluation to provide a thorough understanding of all the issues associated with underwater sensors (both acoustic and non-acoustic) covering all parts of the system from the operating environment through to the operator displays, for both military and civil customers.

The Department undertakes a key role in providing technical advice to MOD on ship, submarine and airborne anti-submarine warfare sensor systems and on sensors to support submarine operations. The Department builds links with industry, ranging from local SMEs, through the water companies, to the largest defence contractors - both in the UK and abroad - identifying civil applications for acoustic sensor technology and developing areas of mutual interest.

Technology skills include a world class capability in sonar hydrophone and projector arrays, sonar self-noise assessment and reduction, and in signal and data processing for sonar technology to provide effective underwater target detection, classification, localisation and prosecution. Modelling skills range across ocean forecasting, sonar system design and performance prediction, performance assessment and evaluation. The department's capabilities are completed with a thorough understanding of ship, submarine and other structure-borne noise, and experience in the design of effective acoustic sensors.



### **Technologies:**

**Oceanography and Remote Sensing:** By the fusion of datasets gathered from various sensors and numerical models, an accurate representation of the undersea environment can be created which can be used in military applications or for oil pollution tracking and search & rescue activities.

**Active Projectors and Projector Arrays:** A well established capability for the development of active transducers covering the frequency band from 400Hz up to 10KHz. There are facilities for modelling performance, in air life testing and evaluation, either in an anechoic tank or at sea. Uses include multistatic sonobuoy systems and helicopter active dipping sonars.

**Towed Array Design and Evaluation:** World class design of towed array systems. Using the latest technologies and materials, designs have been achieved to prove low noise performance, high dynamic range and bandwidths. Capabilities exist to design arrays for seismic as well as military use.

**Passive Transducers, Sensor arrays and Off Platform Sensors:** Research is carried out to support the development of sonar transducers for surface ship and submarine hull arrays, towed arrays, off platform sensors and sonobuoys using both optical and electroacoustic technologies. A service is provided in transducer design, modelling and evaluation. Commercial applications include flow metering in the oil and gas industry, leak detection for the water utilities, seismic exploration streamers and general ultrasonics.

**Environmental Assessment in support of MOD Requirements:** Environmental assessment in support of MOD environmental strategy requirements, drawing on expertise from DERA, other government agencies and academia. As a result of research already carried out, we can offer to undertake environmental assessments in support of research and procurement initiatives as well as operational exercises.

**Active Sonar Processing and Display Systems:** Focused on low cost, adaptable processing, high performance modules permitting the rapid build of prototypes for a wide range of applications. A number of demonstrators have been build using Commercial Off The Shelf (COTS) technologies.

**Sonar Modelling Handbook:** The standard reference for sonar performance modelling within the UK defence community. Distributed widely within DERA, MOD, Central Staff, MOD(PE) and UK industry.

**Sonar System Performance Assessment:** Performance models have been developed for both active and passive sonars and validated using trials data from a variety of sites. The models have been used to support the MOD in specifying the possible performance of future systems and the necessary sonar parameters required to meet that performance and to evaluate the performance of systems proposed by contractors.

### **Capabilities:**

**Physical Oceanography:** Satellite image interpretation from the visible and infra-red images of the early 80's to the many sensor technologies now employed, creating accurate knowledge of the environment to exploit or plan operations at sea.

**Towed Array Research and Sensor Technologies:** Design appraisal and performance evaluation; data analysis methods for design and testing of arrays to meet specific requirements.

**Hull Array and Sonar Dome Design:** Production of designs for different hull forms; consultancy in design of submarine and surface ship hull arrays supporting low noise characteristics both of which are essential to the effective operation of sonar arrays mounted on ships and submarines.

**Active Sonar Modelling:** Infinite element techniques to model low frequency active transducers; acoustic interaction between closely packed high power transmitting transducers; identification and reduction of self-noise. Teams are available to conduct theoretical analysis, collect supporting data and assessing results.

**Sea Trials and Tank Testing:** Extensive experience in trials planning; water space management; ship procurement for trials; design and expediting tests in the Department's anechoic test tank. Particular experience exists in the handling of oceanographic equipment and towed arrays, and the design and deployment of high power acoustic transmitting systems.

**Sensor Data Fusion and Management:** Detection; classification; localisation; data fusion; data management and display in support of specialist understanding to extract the maximum information from the very distinctive underwater environment.

**Active Sonar Data Processing:** Algorithm development; performance evaluation; technology integration; demonstrators, and operational sonar systems. Experience of stochastic processing; Knowledge Based Systems; Artificial Neural Networks; Bayesian Belief Networks. Experience relates primarily to electroacoustic sonars, although the capability to process data generated by impulsive sources is under development.

**Torpedo Detection, Classification and Localisation Systems:** Flexible, compact, real-time capability for recording; beamforming; signal and data processing sonars; speedy prototype capability to process raw sensor data through to expert systems and displays. Emerging techniques for torpedo defence developed around highly efficient COTS sonar systems.

**Environmental Impact assessment:** Assessments of the impact of any form of substance or energy pollution on land or in the sea, using an amalgamation of physical oceanographic techniques; acoustic modelling programmes and data fusion capabilities. These techniques can also support pollution tracking and search & rescue operations.

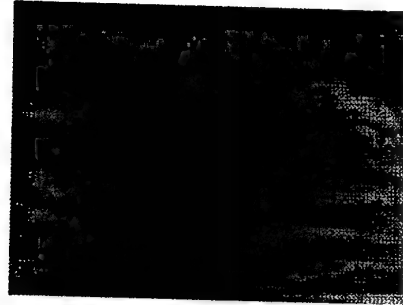
**Sensor Performance assessment:** Sonar data processing and interpretation; system performance prediction and up-to-date expertise in naval tactical doctrine; at-sea sonar measurements on operational platforms; theoretical modelling and computational modelling.

**Acoustic Technology:** Underwater acoustic modelling; sound source design; noise reduction; sensor design; signal processing and acoustic communication systems to develop technology for defence and commercial systems. Areas of interest include acoustic data transmission between ships in hostile environments; ultrasonics; pipe acoustics and leak detection; flow metering; medical acoustics; container scanning systems; security devices and sonochemistry. A state of the art indoor underwater acoustic test tank and data recording system is available.

**Surface Ship Sonar System Concept Evaluation:** Total system capability including all technologies available to specify, procure and integrate both active and passive sonar systems; design and building of acoustic arrays and associated signal and data processing. Modelling capabilities to assess performance of various parts of the system and its performance at sea.

## **RADAR AND TARGET SIGNATURES**

Radar Signal Modelling  
Radar Image Processing  
Radar Antenna Arrays  
Measurement Service  
Low Cost Radar



The Radar and Target Signatures Department undertakes research and radar parameter measurement in the airspace and surface surveillance domains at radar frequencies. The Department's work also extends to electro-optic sensor applications, acoustic detection and classification of battlefield targets, and the development of Low Cost Radar.

The Department offers R & D, Project Support and Consultancy and, whilst not actually engaged in a specific radar design, supports a number of military customer's radar programmes. This is particularly so for the test and measurement facilities operated by the Department.

In excess of 90% of the Department's work is in support of business for UK MOD but extremely close contact is maintained with industry, especially the major UK radar manufacturers: Racal Radar Defence Systems, GEC Marconi (Avionics and Research subsidiaries) and BAe.

Some 10% of the Departments business is generated from defence sources in the areas of the ASTOR and FOAS programmes, selected overseas clients, and a growing client base for the Remote Sensing and Synthetic Aperture Radar Processing capability for environmental applications.

The department is actively involved in marketing the full range of its capabilities and facilities in an increasing number of collaborative activities. This entails, inter alia, attendance at a small number of key exhibitions where common areas of interest are identified for development of visits, business development and information exchange, all leading to opportunities for technology transfer.

### **Technologies:**

**Radar Target Signature Models:** In collaboration with industry and other research bodies, a number of predictive codes have been developed to model targets from the simple to the complex, such as a ship. The only limitations are imposed by the computer hardware used.

**Surface Target Detection Algorithms:** Innovative algorithms have been developed for the detection of surface targets from an airborne platform. A number of products have been developed for image formation (focusing) and data extraction from SAR images, detection of small ships and ship classification in a maritime clutter environment and for 3-D terrain imaging for map generation. A commercially available software package is available for SAR image formation and exploitation.

**Low Cost Radar Systems:** Recent innovative developments for small ground based phased array radar and communications solutions, using a common module approach to construction of a phased array antenna and signal processing, have demonstrated the ability to detect aircraft, vehicles and communication links.

**Radar Cross Section Measurement Services:** This compact range is capable of measuring small targets and antennae in the far field using a frequency range of 2-18GHz, whilst a comprehensive scale model measurement facility, managed by Racal, can measure from VHF to millimetric frequencies.

### **Capabilities:**

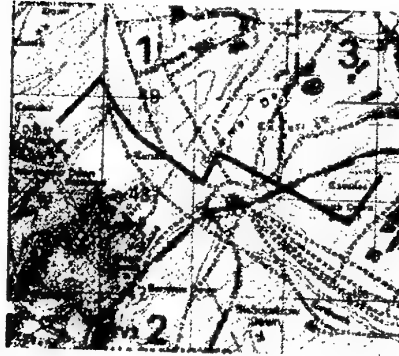
**Surveillance of Air Targets:** Radar capabilities include: airborne pulse Doppler for AI and AEW; space based Doppler for air defence; active phased array; HF Radar; surface and skywave for OTH applications; active and passive techniques for microwave ground Radar; bistatic exploitation of VHF transmitters of opportunity.

**Surveillance of Surface Targets:** Surveillance and attack of surface targets using Radar imaging techniques key knowledge of target and clutter signatures and the application of signal pattern and image processing techniques to radar imagery. Trials gathering using various Radar sensors and aircraft to collect data, including the enhanced surveillance Radar (ESR) mounted in a BAC1-11 aircraft for long range surveillance of both land and maritime environments.

**SHORAD Sensors:** A long history exists of developing innovative solutions for SHORAD sensors - the Rapier system is a direct descendent of this type of work. Recent advances have been made in the architecture of low cost Radar systems for short range surveillance and in novel sensor and seeker applications.

## **SIGNAL PROCESSING AND IMAGERY DEPARTMENT**

Image interpretation and processing  
Pattern recognition  
Information Mining  
Speech Recognition  
Neural Networks  
Distributed parallel simulation  
Parallel processing



The Signal Processing and Imagery (SPI) Department undertakes basic and applied research leading to development, demonstration and assessment of underpinning concepts in: signal processing; image processing and interpretation; pattern and information processing; distributed interactive simulation and speech technology.

The Department consists of a number of strong, multi-discipline research teams with established track records in innovation aimed at current and future requirements.

About 70% of the Department's work is generic long term research. Pull-through of the resulting enabling technology is achieved through participation in applied research programmes and through project support. 15% of the Department's MOD budget is spent on extramural research in Industry and Universities.

Less than 10% of the Department's work is for non-MOD customers but the intention is for this to increase to 20% within 5 years. Over 40 prospects are currently being pursued, covering markets such as security, ITEC (Information Technology, Electronics and Communications), financial services, transport and healthcare. Currently, much of this work is for Other Government Departments (OGDs) but increasingly the emphasis is shifting to collaboration with Industry.

A major challenge being addressed is the funding of foreground development within DERA to convert generic technology into marketable products and services.

## **Technologies:**

**Pattern and Information Processing Techniques:** The quantity of information about us, and the need to use it in everyday life is constantly growing. There is a need to access, analyse, explore, extract, process, fuse it with background knowledge, make inferences and ultimately take informed decisions. Automated support for these activities is provided by a research programme which helps other groups/organisations to solve their processing problems.

**Imagery Exploitation and Technology:** Technical consultancy and computer based solutions are provided for imagery exploitation and dissemination, including support to operational units as well as supplying impartial advice on behalf of the customer to procurement programmes for computer systems for image exploitation and report production. Typical work has included combining several software and hardware components in a seamless way to aid image analysis.

**Aurix:** A complete system for rapidly prototyping speech recognition requirements, featuring a graphical application generator, a speech model building kit, a performance monitor, recogniser software and hardware platforms. The system can deal with continuous speaker dependent, or independent speech recognition, with a start vocabulary of over 1000 words.

**Speech Systems:** The Speech Research Unit offers high performance speech technology including basic algorithm generation, technology integration, application demonstrators and assessment, rapid prototyping, advice on customer requirements, technology tailoring, transfer and licensing. It has a world-wide reputation and is staffed by experts with skills in pure mathematics and statistics, physics, engineering, computer science and linguistics.

**Plumber:** A visual environment for data processing designed for analysing log files but applicable in other domains, eg: finance and insurance. It permits a user who is not a computer programmer to construct data analysis models. Plumber can be animated to produce results of the analysis and to feed the results into visualisation tools or existing commercial software such as Microsoft Excel or a database.

**AdAPT:** Adaptive beamforming and equalisation techniques are becoming important in a wide range of systems including radar, sonar and communication systems, to provide maximum sensitivity to wanted signals whilst rejecting noise, clutter and co-channel interference. AdAPT provides a flexible simulation environment which provides rapid and realistic assessment of real world performance for a fraction of the cost of building trial equipment. Simulation and results can be viewed in a variety of ways including 3-D views of array geometries and beam patterns.

**Automatic Number Plate Reading:** Independent consultancy is offered on all aspects of ANPR technology and its applications, based on a background of image processing and optical character recognition. Recent support given to MOD and HM Customs & Excise has provided a depth and breadth of knowledge in commercially available systems resulting in a demonstrator, and continuing research which is addressing the limits of commercially available systems.

**High Level Architecture (HLA) Simulation:** In order to reduce costs, there is an increasing pressure to construct future simulations from re-useable components. The HLA provides a framework for linking inter-operating simulations in a distributed environment. DERA has a leading-edge capability and, in conjunction with UK industry, has developed a run-time infrastructure for the HLA.

**Distributed Interactive Simulation:** Project support, technical advice and consultancy on simulation in distributed computer environments, particularly in the procurement of equipment for virtual training, including computer networking, image generation, synthetic natural environments and Artificial Intelligence. Active support is given to the Simulation Interoperability Working Group for the transfer of technology with industry, which comprises DERA, Industry and the DTI.

**Optimisation and Heuristic Methods:** Many aspects of military planning can be modelled as optimisation problems. Heuristic methods provide the ability to quickly generate high quality solutions to large and complex operation problems which would otherwise be insoluble in any practical sense. Expertise exists in the application of heuristic methods to planning, optimisation and real-time decision making in large scale military problems.

### **Capabilities:**

**Image Processing and Interpretation:** Expertise covers a wide range of digital image processing and interpretation techniques including:

Theoretical issues; algorithm development and real-time implementation issues on hardware; image segmentation techniques; detection; tracking and classification of targets; model based techniques for object recognition; image to image and map to image matching techniques for image registration & fusion; image content addressable databases; image compression & real-time implementation of algorithms and the development of prototype generic image processing architectures. Also, research into advanced, high dynamic range cameras with both off- and on-focal plane signal processing.

**Pattern and Information Processing:** Research, development and advice on techniques to make sense of data & information and thus aid or make decisions; advanced pattern processing techniques and their practical application. Under development, capability to apply and advise on the use of optimisation algorithms and computer architectures for military planning and real-time decision making.

**Parallel and Distributed Simulation:** Research on key underpinning technologies for Synthetic Environments; application of advanced digital information technologies to distributed simulation and synthetic environments; distributed simulation test-bed facility & experiments with new protocols; participation in national and international exercises to develop distributed simulations, based on new technologies as well as the ability to develop algorithms for parallel complex numerical and geographical software across a range of problem domains from compiler development to financial modelling.

**Signal Processing:** Research into sensor array signal processing algorithms and architectures; long-term theoretical studies of basic principles and techniques; mid-term development and assessment of algorithms by simulation and analysis of trials data; short-term input to project support; impartial consultancy and in-depth research on stable, efficient numerical algorithms; non-linear, non-Gaussian and non-stationary DSP; narrow-band adaptive beamforming and filtering for clutter and interference rejection; super-resolution direction-finding and signal estimation; adaptive filter banks; novel element-digitised phased array architecture and rapid hardware prototyping.

**Speech Technology:** Basic research and development covering algorithm generation; technology projects & applications; demonstrators and assessment; high performance algorithms/systems for use in adverse environments and the provision of design tools for rapid and flexible deployment of multimodal speech based systems. Expertise in related areas including natural language processing and pattern processing of (non-speech) signals.

**Secure Area of Operations:** The secure working area enables the production of material to the highest classification and contains an internal enclosure for the evaluation of non-tempest evaluated hardware.



## SENSOR AND AVIONIC SYSTEMS DEPARTMENT

Sonobouy Data Processing & Display  
Data Acquisition & Recording Systems  
Integrated Avionic systems  
Fault Tolerant Avionic Systems  
Electromagnetic Compatibility (EMC) Facility  
EMC Guide



The Sensor and Avionic Systems Department (SASD) undertakes basic and applied research that leads to the development, demonstration and subsequent production of particular military sensor equipment. The Department is diverse and has expertise in electro-optic sensors for fast jets through to recognised world experts in airborne asw acoustic processors that are required for Maritime Patrol Aircraft. It provides 'cradle to grave' support to its military customers.

The Department accommodates the necessary expertise to incorporate sensor expertise into systems, including modelling of avionic architectures, sonobuoy systems and avionic systems. It is adept at incorporating the total sensor system onto the aircraft platform, and gives collateral support to the user by providing 'mission control' and EMC advice.

Most of the department's current business is in supporting MOD (95%). It recognises this as a major shortcoming and hopes to migrate military technology into civil applications, which it sees as a major future opportunity for wealth creation for UK Industry.

### **Technologies:**

**E-Map Multi-Sensor Data fusion Technique for Maritime Air Missions:** Traditional frequency-based techniques for sonobouys impose unacceptable work-loads on operators. A synthetic geographic display, the E-Map, fuses data and cues the operator to examine regions in greater detail. The technique is being extended to fuse data from other airborne sensors.

**Total Energy Detection Sonobouy Field Processing Technique:** Traditional processing techniques treat sonobouys as individual sensors, whereas they form a distributed sensor field. Total Energy Detection (TED) exploits the geographic characteristics of a sonobouy field.

**ASSAM Model of Sonobouy System Performance:** Future sonobouy systems will be multi-mode and deployed in complex field geometries. ASSAM is a comprehensive sensor-level performance model of sonobouy fields, used to assess novel technologies and trade-offs.

**MODAS Flight Trials Instrumentation System:** MODAS is the preferred airborne data acquisition and recording system for use on MOD trials. SASD can deploy MODAS systems to support customers' flight trials requirements including ground replay and transcription of airborne recordings.

**TIALD Test Sets:** Tests sets have been designed, built and delivered to the RAF to test correct functionality of the interface between the aircraft and TIALD pods of Tornado, Harrier and Jaguar aircraft. Further tests set have been developed for Vinten Recce pods for Tornado and Jaguars.

**MARS Model of Avionics Reliability and Sustainability:** Future avionic architectures will need to exhibit high fault tolerance through modular design, auto-reconfiguration and real-time distributed software. Models such as MARS are required to assess the reliability and sustainability of design options.

**Integrated EM Hardening Design Guide:** This tri-service design is aimed at helping the designer of platforms and associated systems in producing the most effective radio frequency (RF) protection scheme, in terms of cost, maintainability and operational performance, when used in the military environment. In addition, general advice is provided to the programme manager to aid in the implementation of an effective electromagnetic hardening programme.

**EMC Mathematical Models:** EMC testing of equipment/sub-systems and whole vehicles to verify design compliance with national and international standards is necessary but expensive and time consuming. Advanced mathematical modelling techniques offer the prospect of predictive design and minimal testing.

### **Capabilities:**

**Avionic Architectures:** Application of advanced integrated modular avionics concepts to military aircraft and helicopters, including auto re-configuration and real-time software; assessment of actual components against UK requirements; system modelling support to civil programmes; software architectures; advanced data network design and reliability/maintainability modelling.

**Avionics Systems:** Design, development, demonstration and evaluation of current, advanced and experimental integrated avionic mission systems for all types of military aircraft; system design and software development; Radar and sensor data fusion; integrated navigation systems.

**Modular Data Acquisition Systems:** Advice on operation and future development of MODAS system; support to research teams conducting flight trials; provision of effective ground replay systems for post-trials reduction; transcription & analysis.

**Electro-Optic Sensors:** Aircraft applications of E-O sensors to piloting aids; integration with terrain and feature databases and other sensors; integration of steerable FLIR and helmet-mounted displays in visually coupled systems; dual-waveband FLIR using neural network data fusion techniques; multi-spectral targeting; micro-Doppler sensing of ground acoustic signatures; burst illumination lasers; 2-D imaging and vibrometry using CLARA.

**Mission Information Systems:** Analysis of production, management, storage and distribution of information needed for offensive air mission planning, execution and debriefing; application of novel techniques to exploit the diverse range of geographic, aeronautical and mission data types; definition of a common Geographic Data Architecture to maximise consistency and utility of information in ground-based and airborne applications; military product data translation/conversion.

**Mission Control:** Development of data management and decision making routines in ground planning; better cockpit data management to speed-up mission control processes; mission control improvement techniques including pre-mission planning, data handling, airborne mission management, airborne mission re-tasking, post sortie de-briefing and dissemination of information.

**Weapon Aiming:** Accurate 'first pass' delivery of current weapons onto fixed and moving targets using both active and passive sensor suites. Automatic initial target area search, target classification and designation; TIALD laser spot search and track capability; helmet-mounted displays for offset targets; TRN database integration and passive ranging; aircraft-to-weapon transfer alignment techniques.

**Sonobouy Systems:** Sensor-level modelling of sonobouy fields to assess new technology trade-offs; integrated processing and display of geographically dispersed sensors; data-gathering sea trials of experimental, demonstration, development and production systems.

**Air ASW Signal and Data Processing:** Reduction of operator workload through novel geographic displays and fusion of multi-sensor data; identification and evaluation of current and near-term processing and display technology for insertion into in-service systems; support to operational evaluation exercises.

**Electro-Magnetic (EM) Hazards and Protection:** EM environmental assessment; EM vulnerability assessment; development and assessment of EM hardening procedures and design guides; development and validation of mathematical models of coupling to platforms and circuit modelling; management of European civil aircraft EMC research club; development of new test procedures leading to new national and international standards.

**Research Vessel "Colonel Templer":** Comprehensively equipped, ultra-quiet, deep sea research vessel fully classed to UK standards for world-wide operations; well equipped air-conditioned laboratories complemented by cranes, winches and "A" frame capable of overboard deployment of equipment up to 5 tonnes; satellite communications and navigation.